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Is Philosophy a Branch of Science?

Since engineering is science applied to economic ends, every engineer should be always interested in pure science in general, and particularly in those branches of pure science that relate to his own engineering specialty. But here comes a difficulty. How are we to distinguish what relates to our specialty from what does not relate to it? The sciences are becoming so interwoven that they may eventually merge into one science—the science of energy. Physics and chemistry, as a result of the discovery of the electron, are fast becoming mere branches of electron science. The spectroscope carried the astronomer to the sun and discovered there a new chemical element, helium, before the chemist had found it on the earth. Periodic changes in the ring thickness of trees tell the botanist a story of sunspot changes for the past 3,000 years; and the geologist finds a similar story in the periodic changes in the thickness of annual silt deposits in ancient lakes, going back ten times 3,000 years. Planets as yet beyond the vision of any telescope are causing sunspots, sunspots are causing barometric changes, barometric changes are causing rain, rain affects crops—and so that most ancient and basic of all industries—agriculture—may yet find itself beholden to the astronomer for guidance in planting seed.

The sciences are more than threads interwoven to form a texture of general knowledge. Rather do they fuse and alloy with one another. To know the most about one science we must know something about all. If, then, philosophy is a science, it, too, should be studied by engineers. But is philosophy a science? Is it even scientific? Perhaps it started as a science. Certainly the old term "natural philosophy," indicates that it did. But modern philosophy, aside from Spencer, is mostly a melange of ultra-science, metaphysics, morality and religion.

In his "Story of Philosophy" (one of the best sellers among the serious books of the day), Durant says: "Every science begins as philosophy and ends as art; it arises in hypothesis and flows into achievement. . . . It is the front trench in the siege of truth. Science is the captured territory. . . . Philosophy seems to stand still, perplexed; but only because she leaves the fruits of victory to her daughters the sciences, and herself passes on, divinely discontent, to the uncertain and unexplored. . . . To observe processes and to construct means is science; to criticize and coordinate ends is philosophy. . . . Science without philosophy, facts without perspective and valuation, cannot save us from havoc and despair. Science gives us knowledge, but only philosophy can give us wisdom."

Note how Durant starts by telling us that philosophy makes the first steps in all scientific discovery, namely the formation of hypotheses or tentative theories of how effects are produced; and then ends by telling us that philosophy is a sort of super-wisdom, a knowledge deeper than any scientific theory, a divination of divinity. There is contradiction here at the very first of his book. Either he has no definite idea of what it is all about—this philosophy—or he is unable to specify its realm. Surely philosophy can't be both the first guess as to how effects are caused, and at the same time be a final summary and appraisal of the fruits of science. Yet he hasn't outlined badly what his 20 selected philosophers have attempted to do, from Socrates to John Dewey.

The professional philosopher is a rather pathetic creature. He starts by attempting to solve the most difficult riddles of the universe. He fails, yet he ends by telling science that it knows nothing profound. He poses all the while as a scientist, yet rarely uses the methods of science. What is more, not one of the 20 philosophers whose doctrines Durant expounds, is the discoverer of a single scientific law or principle of importance. Even the greatest science ballyhooer of them all—Sir Francis Bacon—the man who was for long acclaimed the father of inductive or experimental science, even he never discovered a single law of nature. Exactly as he accepted bribes when he was a judge, and saw no great wrong in it, so he stole what few ideas of scientific methods he was able to decipher from the writings of Galileo and other true scientists. He muddled the whole up nicely, but gave it to the world with stentorian authority, and actually became worthy of praise because he caused men to ask: What is this new thing called experimental science?

Herbert Spencer is the only one of the 20 who had any considerable training in physical science. He started as a civil engineer, but soon abandoned his profession to become the great exponent of the theory of evolution. He was not the originator of the theory, but, like Huxley, he made it widely known.

Consider the sublime egotism of a man who admits that he never worked in a scientific laboratory, never studied the stars with telescope or spectroscope, never was the first to trace the simplest physical effect to its

causes, yet essays to solve problems more profound than have yet been solved by any Isaac Newton! You may admire such grand presumption, but you come to know that it is founded upon an ignorance that is even greater.

Small wonder, then, that "philosophy stands still," or rather whirls like a spinning dervish on a circus tub. Let us be rid of the superstition that there is a science more profound than science, and that its name is philosophy. Call these speculations philosophy if you please, but please do not call them science.

H. P. Gillette

Financing Water Mains and Sewers

Front-Foot Assessment Basis Discussed in Journal New England Water Works Association

By A. E. WALDEN
Chief Engineer, Baltimore County Metropolitan District, Towson, Md.

We have been operating about three years on a front-foot assessment basis, owing to the fact that the commission considered it best to assess the cost in this manner, until such a time as they would have more information as to what portion of the cost should be considered strictly a benefit to the abutting property and what part was undoubtedly a benefit to the sub-districts or district, as a whole. This general cost would be spread over the entire district. At present we are determining the taxable basis in the sub-districts, as distinct from that of the county at large, for the purpose of distributing the total costs between the combined front-foot assessment and a general property tax, if found advisable sometime in the near future.

The Metropolitan Commission has expended a little over three million dollars out of an issue of bonds amounting to over five million dollars. The installation of water and sewer facilities has resulted in an increase in real and personal property in 1926 in the district of seven million dollars over the average of the preceding three years. The real and personal property is increasing at about the same rate, notwithstanding the fact that there has been somewhat of a slump in real-estate activities during the past year.

Since May, 1924, the Commission has installed over 125 miles of water mains, varying in size from 6 to 16 in., and about 80 miles of sewers, varying in size from 6 to 20 in. The average cost per foot for water mains, including some Class "C" pipe, was $3.15, and for sewers, including all house connections, $4.06.

Financing House Connections.—House connections for sewers at this time are charged for at $1 per ft. for half the street width, the measurement being taken from property line to property line and the charge being uniform to each abutting property owner. The minimum charge to each property owner is $15, taking a 30-ft. street, the unit on which the charge is based. One dollar per foot is added for any greater width of street. The balance of the construction cost in excess of $1 per ft. is carried in the regular front-foot assessment. A certain amount of working capital will have to be provided for the installation of future house connections, after the initial collecting system has been completed. The future property owner will probably pay a greater portion of the cost for future house connections.

Meters and meter boxes are paid for by the commission and the charge is carried in the construction cost, with the exception of the meters installed on city-owned mains. When a reduction in the charges for service rendered and water consumed on city-owned mains is made, a small assessment will be made on the abutting property owners to provide for the cost of these meter installations.

Service connections for water are paid for in advance by the property owner. The minimum charge is $16 for a ¾-in. service, $4 being added for opening an improved street.

On Metropolitan-owned mains there is a meter service or ready-to-serve charge of 60 ct. a quarter for a ⅝-in. meter, and a proportional increase in the charge for larger sizes. The water-consumption charge provides for the cost of maintenance and operation of the water service, and the sewer-operating charge provides for the cost of maintenance and operation on a yearly basis.

The installation of water mains under the Metropolitan Act has resulted in a direct benefit to the residents in the district, inasmuch as there has been a reduction in the cost of water to those consumers, on Metropolitan District owned mains, of a little over 25 per cent and a slight reduction to county residents on city-owned mains. Both of these classes of consumers, as the sytems extend, will undoubtedly receive further reductions. Fire hydrant rentals have been reduced from $45 yearly to $36 on city and to $24 on Metropolitan District owned mains.

Experience with Front-Foot Method.—The application of the front-foot assessment and the method of its determination were not generally understood and, therefore, created some agitation and friction, due to the fact that some property owners desired to escape payment of any assessment, even though they were directly benefited; while others have contended, and with some justness, that the assessment should not be entirely on the front-foot basis. Any other method of assessment on a new project, such as this, would have created, however, the same friction, owing to the lack of data as to exemptions to be made and the proper classification of the property to be served. As the method became more generally understood, this opposition practically died out. In many instances, citizens assumed 2 ft. of assessable frontage for each foot of pipe laid. This is not the case, however even if consideration is given to the fact that the cost of crossing streets and alleys and the frontage of triangular and irregular shaped lots must be borne by the front-foot assessment as a whole. The assessable frontage obviously lies between one and two front feet for each foot of pipe laid. The average in the Metropolitan District at this time is about 1.4 assessable front feet per foot of pipe laid.

In some instances prior to the Metropolitan program, in the subdistricts and in one small subdivision, assessments were made practically entirely on the value of improvements. The assessment on the land abutting on the sewer system being ridiculously small, and a large proportion of the total assessment being carried by the majority of the property owners having improved property, it was clear that neither the straight general tax nor the straight front-foot assessment was satisfactory when taken alone, but that the combined general property tax and front-foot assessment were preferable. It is the only method that presents a fair and reasonable restraint on those individuals who invest in idle property with a view of gain resulting largely from the activity of others. The existence of such undeveloped property increases the cost of the utility passing the premises.

A careful study of the conditions can only lead to the conclusion that, for any municipality, the most equitable way to distribute the cost of water mains and sewer installation is on a combined front-foot assessment and general property tax basis.

There is ample evidence that, where the assessment for the cost is in the general levy, or extensions are made and financed from the general levy or property tax, property owners who have already paid for their share of the cost of the original installation of a system of water mains or sewers, are never entirely relieved of the burden of this tax for future extensions, from which they receive little of no benefit. In addition, property owners in outlying districts will not receive the benefit of the water supply and sewerage system for many years. In the meantime they are compelled to pay, through general taxation, for benefits that they may never receive.

The Design and Construction of Small Filtration Plants

Problems of Plants Serving Communities of 1,000 to 10,000 Population

By HOWARD K. BELL
Consulting Engineer, Lexington, Ky.

THE capacity of filtration works intended to be covered in the range of this paper are those ranging from 100 to 1,400 gal. per minute and serving communities of from 1,000 to 10,000 population.

Principal Design Factors.—The principal factors determining or modifying the design of small purification works are:

1. Available funds.
2. Probable demand.
3. Character of supply.
4. Reservoir storage.
5. Operating force.
6. Character of power for pumping.
7. New layout or addition to old pumping plant.
8. Topographic characteristics of site and grounds available.
9. Probabilities of future expansion.
10. Climate.
11. Fire service.

On account of the large number of varying conditions encountered, the writer has never found it possible to use an old design in a new location. He has found that no two problems are enough alike in their factors to avoid a new design in each case.

Taking up briefly the items influencing the design, the wirter has the following remarks to make regarding each:

Available Funds.—As funds available for improvements to small water plants of the class covered by this paper are usually very limited and the necessity or advisability of the improvements and their success often doubted by those furnishing the money, the first and foremost question in the study of a new project is how much money is available or how much can the client afford to spend? Rarely is there sufficient money to avoid cutting out or cutting down on some of the less necessary features or is there any to spend for architectural effects. After determining the capacities required, the money available will influence the size of settling basins, determine whether one or duplicate compartments will be built, influence size of clear well, source of filter wash, character of gauges and controlling equipment, materials for drainage, intake layout and equipment, system of heating, chemical feed and handling equipment and storage, character of materials for housing and extent of building. The problem of building a purification plant to suit the purse of the client is similar to that involved in the purchase of an automobile. There are cars in the utility class ranging in price from $500 to $2,000, any of which will carry the owner over the road, and similarly filter plants in the half million gallon class can be built from $15,000 to $30,000 depending upon equipment, housing and size and character of appurtenances.

Probable Demand.—The probable daily demand will largely determine the capacity of the works to be built. A town of 2,500 will usually require 100,000 to 125,000 gal. per day with a metered system or about 50 gal. per day per capita and without meters, will usually consume 250,000 to 375,000 gal. per day or 100 to 150 gal. per day per capita. Figures as low as 30 gal. per capita and as high as 150 gal. have come within the writer's observation. Usually new filter plants are wanted on unmetered supplies, if for old works, and metering usually follows closely after installing filters. A safe basis for estimating demand, where there are no usual industrial and commercial conditions and water is to be used mainly for domestic purposes, is 50 gal. daily demand per capita where meters are in use or intended and 125 gal. where water is sold on flat rates.

After determining the probable demand, the capacity of the plant to be built will then depend also upon one or several of the other factors. For instance, a metered town of 2,500 inhabitants will consume 100,000 to 125,000 gal. of water per day. A filter plant having a capacity of 200 gal. per minute or 12,000 gal. per hour will furnish this in from 8 to 10½ hours, and would in some cases, prove sufficient. Other factors such as fire service, operating force, reservoir capacity, and probable future growth will usually determine in favor of a half million gal., or 350 gal. per minute supply for a town of this size.

Character of Supply.—The majority of water supplies in Kentucky are from surface streams. Impounding reservoirs for surface supplies probably comes next. Ground water supplies from wells probably come close to the reservoir supplies in number while a few springs also furnish all or part of the supplies for some communities. These large springs usually are from underground streams in cavernous limestone and are fed surface water from sinks in time of heavy rains, hence they have most of the characteristics of surface streams in all but temperature and the carrying of leaves and other drift.

A supply taken from a stream subject to wide and sudden variation in turbidity and depth will naturally require a filter plant having an entirely different layout and dimensions of some important details from one using, an impounded supply. The steam supply will usually require larger settling basin capacity, a more elaborate intake and the topography of the site also be different calling for a different arrangement of its principal features and building.

An impounded supply usually has but a small and slowly changing range in turbidity, hence large settling basins are not usually necessary. The intake in this case can usually consist of merely an adjustable suction pipe with some system for controlling from a bridge or shore. The addition of an aerator is usually desirable for impounded supplies in order to assist in the removal of odors caused by algea during the summer months. Impounded supplies can frequently be built without the use of raw water pumps by placing plant below impounding dam, the raw water being delivered by gravity to the filters.

Well water supplies in Kentucky have been given treatment for removal of objectionable elements in but few cases. A number could be softened to advantage while quite a few more need treatment for iron removal. As softening is comparatively expensive for treating entire city supplies, this is being practical but little except for industrial purposes. Well waters carrying even small iron and sulphur content should be treated for their removal. The iron is precipitated by aeration followed by settling in basins similar to those used for removing turbidity from surface waters. This should be followed by filtration to remove the finer particles of red precipitate and leave a clear water. The settling basins for iron removal should usually give from 6 to 12 hours retention, but filters may be operated at a higher rate than for ordinary turbid surface waters. Aeration may be accomplished by the air lift from the wells, spray nozzles, spray pipes, or water falls, all of which have proved

nearly impervious as possible as the least dampness penetrating even part way into the walls may at some time cause frost and its bursting and disintegrating effects. Corners should be cut across diagonally so as to thicken concrete at these points and special reinforcement placed across near inside of walls. Frost seems to have a way of attacking basins at the corners where there is double exposure and a tendency toward cracks on the inside from the nature of the stresses in a rectangular basin.

Fire Service.—Usually fire service is included in functions of a city water supply and this service will place a limit to the cutting down of capacities of filters and clear well storage which might otherwise frequently be cut in half to save construction costs. The half million gallon plant (350 g. p. m.) is as small a capacity as can be made to furnish this service. When filter plants are built smaller than this, dependence for fire service must be entirely upon reservoir storage or such storage in combination with enlarged clear well and pumping capacity.

SPECIAL FEATURES IN THE DESIGN OF SMALL PLANTS

Grouping of Parts. — Compactness and economy in design and convenience in operation are largely controlling factors in the grouping of the various divisions of a filter plant.

Filters.—The writer's practice has been to build in two units plants having capacities of one half to one million gallons. Below the one half million gallon size, one unit plants have been built for economy's sake. Above the one million gallon size the practice has been to use the one half million gallon unit for whatever number of units are required, using a sand area of 200 sq. ft. for the unit of this rating or 400 sq. ft. to the million gallons per 24 hours. Half million gallon pumps usually have a range of 300 g. p. m. to 415 g. p. m. between empty and full reservoir and the oversize permits of the larger draft.

V-shaped concrete wash troughs are used. Concrete construction prevails in the building, so this material is easily adapted to this purpose.

Strainer system is of writer's special design mainly of concrete construction also and with exception of ⅜ in. brass nipples and glass traps, is built on the job.

Gauges, Controllers and Meters.—The type of gauges used is determined mainly by available funds. For one million gallon plants and larger the customary practice has been to use gauges of the floor stand and dial type usually four in number; two "loss of head," one "clear well" and one "wash water tank." For smaller plants the practice has been to use float tubes with painted board and indicator gauges. In the construction of plants smaller than one million gallons daily, such matters as fancy gauges, intricate rate controllers, dry feed chemical machines, venturi meters, operating tables and, in very small works, valve stands can be made to form a very large part of the cost, the proportion being out of reason when compared to the other construction. It will be seen that these items are almost the same for a half million gallon plant as for one twice as large, hence the necessity of other and cheaper substitutes. Although any engineer likes to see nickel plated gauges and appliances in a filter plant, the board gauge shows the operator everything the more costly one does and is easier kept in working order.

For a rate controller the writer has developed a combination of orifice box and float valve control for the filter effluent which gives a visible discharge in a white tile lined box. This same device is so placed in relation to the clear well that it acts as a clear well control also within certain limits. For instance when pumps are first started with clear well full and reservoir down, they pump faster and well drops leaving orifice free. This causes filters to run at maximum rate setting. As reservoir fills, pumps slow down and clear well rises finally flooding orifice and reaching point where filter output and pumping are balanced. When pumps are shut down clear well fills and floats cut off filters.

For plants one half million gallon and smaller, ordinary meters of the impulse turbine type have been used. The half million gallon plant can be serviced by a 4 in. meter with a loss of less than 3 lb. pressure and at a cost of about $175. The ordinary meter set in the discharge line will not give the rate of flow on a chart as will the other types, but it gives the operator and the water company a record from which daily consumption can be checked, also the performance of the pumps can be checked from the same source. For the one million and a half gallon plants a 6 in. meter is required. This costs about the same as the flow meter, orifice type, so the latter is the logical device in such plants. These cost about $360 installed and are furnished with daily charts recording the pumping rates and giving in figures on a dial the total quantities pumped. In the writer's opinion, no water plant, however, large or small should be without some such meter as the knowledge so obtained forms the basis for all estimates for improvements, comparisons of costs of operating, checking waste and leakage, power costs and chemical dosage.

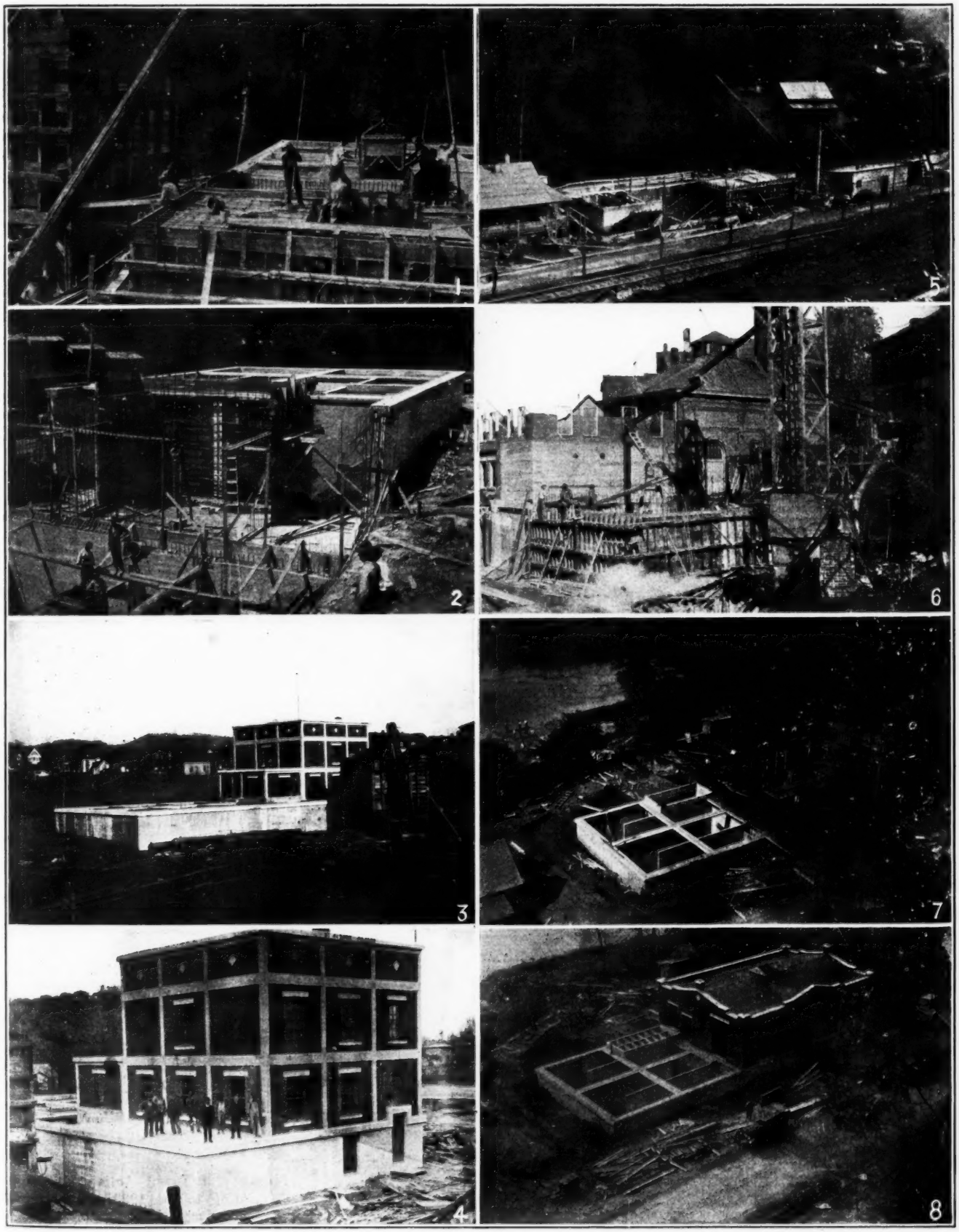
Filter Wash.—For reasons of economy, plants smaller than one million gallons daily have been designed to use the high pressure from the main lines to reservoir for back wash to filters. A wash pump or a wash water tank will cost from $1,500 to $3,00 installed, which is quite an item for the small plant. For one million gallons and upwards, the writer's practice has been to build a wash water tank filled from high pressure discharge line and controlled by a float valve. For a plant now under construction, the wash water tank will be filled from the clear well by a special pump of 100 g. p. m. capacity and with 3 HP. motor. This will save the waste in electric current otherwise required for pumping the wash water against a 260 ft. head as against 50 ft. The cost will be about $250 for this pump installed and saving incurrent should pay this cost in a little over a year. Where power is supplied within the same plant, the saving will not be so noticeable and with some plants the use of such pump would not be practical.

The writer's practice has been to build the wash water tank in the roof of the building over the filters. This is easily done with concrete construction and water tightness not difficult to obtain, as depth of water is usually not more than 4 ft. The head used is about 23 ft. average on the wash troughs allowing about 10 lb. pressure for washing purposes. The flat shape of this tank gives a nearly unifrom washing head. Tanks are built to contain 30,000 gal., which is sufficient for washing two half million gallon units. The cost of such a tank for extra concrete and brick work added to the building is from $1,500 to $1,600 or about the price of a wash pump and motor.

Chemical Storage. — The chemical storage for plants smaller than one million gallons is usually taken care of in an outside frame storage shed. Plants of this size usually have housing areas too small for much storage of materials. The chemical feed apparatus is usually on operating floor in these plants with no partitions separating it from the rest of the building. It is advisable therefore to carry chemicals in pails or bags as required in order to keep the operating floor in a neat condition.

For plants of one million gallons and upward the practice has been to provide storage for one car load of alum and a reasonable supply of hydrated lime, which can always be purchased locally as wanted. This storage is provided on floor in space between operating floor and wash water tank. Materials are hoisted from trucks to door at this floor level from outside and stored at convenient location for loading chemical feed hoppers through openings in floor. Chemical feed apparatus is housed in room containing mixing chamber equipment and partitioned from other parts of building for preventing dusting and slopping with these objectionable materials.

Mixing Devices.—Smaller sized plants have been provided with timber baffled mixing chambers, preferably shallow in design for construction and cleaning convenience. These mix the raw water and chemicals by agitation from reversing direction of flow and are de-



(1) Construction of St. Albans, W. Va., Filter Plant. Only 10 Men Were Required on This Job to Handle Concrete from 2-Bag Mixer. Aggregate Bins Were Filled from Railroad Siding by Conveyor and Concrete Placed by Derrick and Bottom Dump Bucket. (2) Progress View of Filter Plant at St. Albans, W. Va. Settling Basins Are in Background, and Clear Well in Foreground. (3) Finished Filter Plant at St. Albans, W. Va. Settling Basins in Duplicate Are in Center. Low Brick Extension to Cover Mixing Chamber. Three 500,000-Gal. Filters Are Housed Partly in First Story of Brick Building. Middle Story Contains Chemical Storage, Tops of Solution Tanks and Laboratory. Top Story Contains 40,000-Gal. Wash Water Tank. (4) Front View of St. Albans, W. Va., Filter Plant. (5) Pouring Filters at 1,000,000-Gal. Plant at Harlan, Ky. Derrick with Bottom Dump Bucket Used. (6) Construction View of Filters at Versailles, Ky. (7) Construction View of Filter Plant at Williamsburg, Ky. (8) Williamsburg, Ky. Filter Plant About Completed. Note Concrete Baffled Mixing Chamber Partially Above Settling Basin

signed to provide 15 to 20 minutes retention.

Larger plants are being designed with an agitator of revolving paddles for stirring the raw water during the mixing period of 20 minutes to 30 minutes. Both systems have given satisfactory results, but the mechanical agitator produces a larger floc that is more quickly precipitated in the settling basin. Agitators may be driven by either water or electric motors with speed reduction gears.

Settling Basins.—These are usually designed to give about 4 hours retention period with an allowance of from 12 to 20 per cent of dead space. Larger basins have been built for 6 to 7 hours settling time where extremely muddy waters have been encountered. The tendency in design has been towards cutting out or reducing baffles and allowing lower velocities in a straight line. These velocities range from 10 to 17 ft. per hour as against velocities as high as 30 ft. per hour with baffled basins The lower velocities give greater efficiency in sedimentation, provided proper distribution is maintained over the cross section of the basin. This is done by means of distributing inlets and outlets and perforated walls. Sufficient drainage outlets with convenient facilities for washing should be provided. When washing of settling basins is made difficult by the design, this matter is naturally neglected in operating. Convenient connections for 1½ to 2½ in. hose with racks for holding and convenient manholes with permanent ladders assist in this work as do also outlet valves with stands over tons of basins.

Drainage.—Inside of buildings the drain pipes are usually of cast iron soil pipe or sewer tile encased in concrete. Ample drain pipes and abundance of floor drains assist greatly in keeping plant in a liveable, presentable and sanitary condition. Main drains from filter wash must be of ample size or washing can not be effective. A one fourth million gallon unit requires a 12 in. drain pipe from building and a one-half million gallon unit requires 15 in. to 18 in. depending upon length and grade. Drippings from condensation on pipes and waste from pump priming cause a nuisance if not properly disposed of. Floor gratings with pipes or troughs beneath can frequently be used for this purpose.

Acknowledgment.—The foregoing is taken from a paper by Mr. Bell, presented at the annual meeting of the Kentucky-Tennessee section of the American Water Works Association, held at Louisville, K., Jan. 19 to 21.

Miami Announces New Bulldozer

The Miami Bulldozer or Front Blade Back Filler, recently announced by the Miami Trailer-Scraper Co., Troy, Ohio, is designed for attachment to the Model 20-K Cletrac Tractor. It is a power operated front blade back filler and the fastest operating unit of its kind on the market today.

The blade of the Front Blade Back Filler is controlled by the Miami Power Winch which attaches to the Power Take Off on the rear of the tractor. The positive control of the blade through the Miami Power Winch enables the tractor driver to instantly raise or lower the blade as desired. The tractor driver engages and disengages the clutch on the Miami Winch for raising or lowering the blade. This can be done with the tractor either in forward or in reverse motion. The tractor never stops.

On an actual test one man using the Model 20-K Cletrac Tractor and Miami Front Back Filler back filled a sewer trench measuring 3 ft. wide by 6 ft. deep at the rate of 100 ft. per hour, according to the manufacturers.

This unit is not only suitable for trench back filling work but may be used for leveling purposes, for small grading operations for spreading gravel, crushed stone, etc., for pushing dirt over fills and for moving snow.

The New Miami Back Filler on the Job

Parsons Backfiller Does Six Jobs

The Parsons 32 Backfiller, manufactured by the Parsons Company, of Newton, Iowa, is said to be an unusually handy rig for the contractor since it is equipped to do six different jobs. It provides a source for compressed air without the need for the purchase of a separate compressor. It is equipped with an alley device that permits backfilling in the narrowest of alleys. It is equipped with a handy push scraper that permits the dirt to be either pushed or pulled into the trench even in close quarters. It can be rigged as a skimmer scoop for handling and loading loose material into trucks and for cleanup work after backfilling, and it can be quickly rigged as a handy little clamshell crane. Besides these uses, it is designed to be used as an ordinary backfiller.

As to performance, it is said to be capable of handling a good amount of dirt, and to be an efficient and reliable machine. A several-purpose machine like this is said to reduce the contractors' expense for plant and to be therefore quite worth while.

Missouri Valley Water Works Men to Meet.—The 14th annual meeting of the Missouri Valley Section of the American Water Works Association will be held Oct. 2-5 at the Kansas City Athletic Club, Kansas City, Mo. Jack J. Hinman, Jr., P. O. Box 313, Iowa City, Ia., is secretary. The Missouri Valley Section—formerly the Iowa Section—is composed of the states of Iowa, Kansas, Missouri, South Dakota and the eastern half of Nebraska.

Market for Dried Activated Sludge.—According to the 1928 annual report of the Sanitary District of Chicago, dried activated sludge has proved excellent for uses on golf courses, particularly on the greens, and in gardens. For 1928 the District has set a price of $25 per ton f. o. b. cars in small lots and $22.50 f. o. b. cars by the carload.

Digestion of Vegetable Wastes and Screenings in Sewage Treatment Plants

Results of Studies* Made by Department of Sewage Disposal of New Jersey Agricultural Experiment Station

By WILLEM RUDOLFS and H. HEUKELEKIAN

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STUDIES made in our laboratory on the decomposition of sellulose and cellulosic materials, (toilet paper, etc.) have shown that such substances are decomposed rapidly in digestion tanks when the tanks are in good condition. Troubles are usually encountered when the tanks are slightly acid because cellulosic materials produce in the processes of decomposition quantities of organic and inorganic acids. These studies led the way to a further study of the digestion of vegetable wastes and fine screenings which contain proportionally large quantities of cellulosic (vegetable) substances. It was deemed advisable to study the digestion of vegetables wastes, because certain industries are turning out such waste continuously, while others do so during certain times of the year, often without adequate methods of disposal. It is also a question whether or not such vegetable wastes should be kept out of a sewage plant treating domestis waste further. Further can garbage be efficiently digested in combined systems or should we search for improved methods of separate garbage digestion.

The work carried out thus far by us is by no means complete, and the results given are only preliminary in character. However, we thought it of interest to find out something about the rate of digestion of materials like vegetable waste and fine screenings and give the results obtained thusfar. If such wastes change the rate of digestion of the mixture the question arises "How great an increase in digestion capacity would be necessary if such materials are handled by a digestion unit of a sewage treatment plant."

Difficulties Encountered.—Dufficulties were encountered in this study from the beginning. The first and obvious one was the procuring of samples of garbage which would be fairly representative. The composition of garbage would naturally vary within wide limits with the season and with the community. Screenings from disposal plants can not be taken as representative of garbage because they not only contain the finer particles of kitchen waste, but they are also much higher in fats, grease and soap, as well as nitrogenous substances present in the feces. It was evident, then, that screenings and garbage should be studied separately. Instead of going to the local incinerator to collect large quantities of garbage for sampling it was thought wise to start with a mixed vegetable waste which had accumulated for some time from a kitchen. It contained a great variety of vegetable refuse, including potatoe peelings, cabbage leaves, rinds from oranges and grape fruits, spinach, beets, carrots, etc. This material, as well as the fine screenings was finely ground to secure a more even mixture and better samples for analyses.

Some results on the digestion of fine screenings have recently been published[1] by the junior author and we will refer to that part of the work only incidentally, but discuss more in detail the digestion of vegetable waste.

Procedure.—Since it has been demonstrated by us that there should exist a proper relation between ripe sludge and fresh solids all our experiments are conducted with materials mixed in definite ratios. The ratios are based on the volatile matter content of both the ripe and raw material, because variations in ash content of different sludges and raw wastes vary greatly over the country. The ratio selected for this study was on the basis of volatile matter content I part ripe sludge to 2 parts raw material. A mixture of ripe sludge and fresh domestic sewage solids will be digested (digested in the sense of ready to draw) in from 30 to 35[2] days, provided the temperature of the mixture is kept at 70° F. The vegetable wastes were added in conjunction with fresh solids to ripe sludge in ratios of 1:1:1 (1 vegetable + 1 fresh solids + 1 ripe sludge) and 2:1:1, the latter receiving twice the amount of vegetable waste. It should be noted that while the first mixture is properly seeded according to our present knowledge, the second contains an excess of raw material.

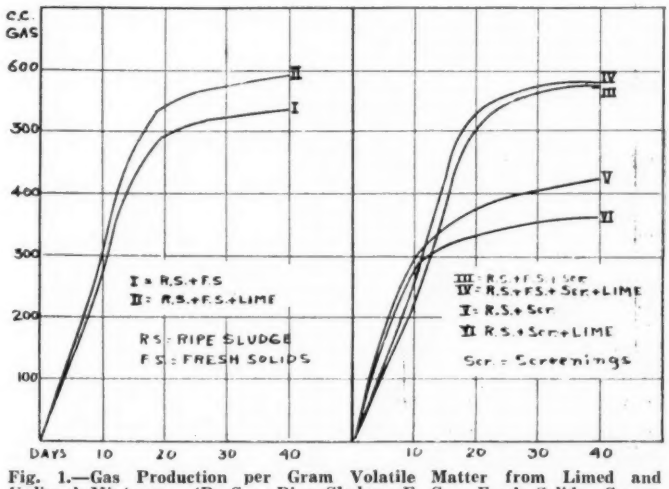


Fig. 1.—Gas Production per Gram Volatile Matter from Limed and Unlimed Mixtures. (R. S. = Ripe Sludge; F. S. = Fresh Solids; Scr. = Screenings; Ratios Refer to Volatile Matter in the Different Components.)

It was determined that if the sewage was not screened the tanks would receive approximately 12 per cent more volatile matter. So to a proper mixture of ripe sludge and fresh solids and additional 11.2 per cent screenings (on the basis of volatile matter) was added. In another series of experiments screenings replaced the fresh solids altogether, since it would possibly be more advantageous to digest screenings separately rather than in conjunction with fresh solids. In still another series vegetable waste displaced the fresh solids, so that we had combinations of ripe sludge and fresh solids, ripe sludge and screenings, ripe sludge and vegetable waste, combinations of ripe, fresh and screenings and combination of ripe, fresh and vege-

*Paper No. 61, Department of Sewage Disposal, N. J. Agricultural Experiment Station, New Brunswick, N. J.

[1]Public Works, Dec., 1927.

[2]Elaborate results, discussions and conclusions on the time required for digestion under different conditions are set forth in a bulletin in press at this time.

table waste. A duplicate series was run for each mixture, to one of which lime was added to adjust the reaction to a pH value of 7.4. As all these mixtures were connected with gas measuring apparatus and could not be opened while the experiment was in progress, frequent pH determinations were made on a series of triplicates from which the amount of lime to be added was calculated. Lime was added through a check valve so that air could not enter. Analyses of the gas were made occasionally on samples from gas collected over certain periods. The basic figures for the different mixtures are given in Table I. It is of interest to note that the screenings have a much lower ash content than fresh solids, while the vegetable waste had an ash nearly alike to fresh solids.

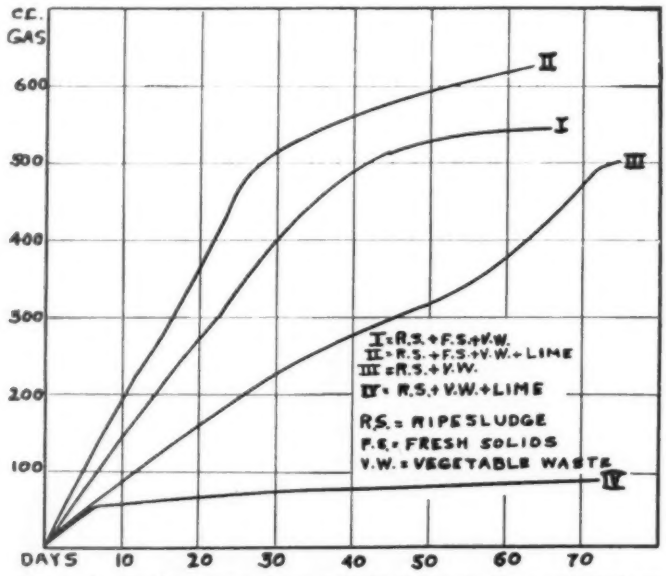


Fig. 2.—Gas Production per Gram Volatile Matter in Limed and Unlimed Mixtures of Ripe Sludge, Fresh Solids and Vegetable Wastes. (V. W. = Vegetable Waste.)

Results.—The daily gas production from screenings, ripe sludge and fresh solids mixtures is given in an accumulative form, on the basis of a gram of volatile matter originally present in Fig. 1. The daily increments of gas are more or less alike for the limed and unlimed mixtures of fresh solids and ripe sludge mixture, being slightly higher in the former. The maximum production took place in 20 days, after which only small amounts of gas were produced. As far as gas production goes, the digestion in this mixture was complete within 20 days, but such mixtures have not always reached sufficient stability to allow them to draw. They may still have an odor. There was a different state of affairs when vegetable wastes replaced a part or all of the fresh solids (Fig. 2). When they replaced a part of the fresh solids, gas production was retarded considerably, but not so much as when they replaced all of it. In a mixture of vegetable wastes, fresh solids and ripe sludge in the ratio of 1:1:1, maximum gas production was completed only at the end of 40 days, that is, it took twice as long as the control. The additions of lime accelerated the rate of gas production considerably, but even this mixture lagged behind the ripe sludge—fresh solids and the ripe sludge—fresh solids —screenings mixtures. Gas production was almost nil when vegetable waste was added to the ripe sludge. However, the addition of lime to this mixture was very favorable (Fig. 2) but still retardation of gas production was marked. The difference between the two latter cultures was one of reaction only (corrected with lime in one case) and the retardation can be attributed to the acidity produced by the material employed. It should be borne in mind that anaerobic conditions are not conducive to the digestion of substances producing much acid. It is clear therefore that ripe sludge can not take care of the same quantity (dry weight) of vegetable waste as fresh solids which contain a considerable amount of nitrogenous substances. This does not mean that material of such a character cannot be decomposed readily under a different set of conditions. In our publications we pointed out over and over that wastes which change the character of domestic sewage, whether it is inorganic or organic factory waste, must be taken care of under modified conditions.

Table I.--Basic Figures for the Different Mixtures.

Mixture	Fresh solids gm.	Ripe sludge gm.	Vegetable waste gm.	Screenings gm.
1. Ripe sludge + fresh solids (1:2)	1460	750	.....	.....
2. Ripe sludge + fresh solids + vegetable waste (1:1:1)	730	750	132	.....
3. Ripe sludge + fresh solids + vegetable waste (1:2:1)	730	750	264	.....
4. Ripe sludge + fresh solids + screenings (1:2:11.2%)	1460	750	.....	70
5. Ripe sludge + screenings (1:1)	.....	750	.....	264

	Solids %	Ash %
Fresh solids	5.17	20.5
Ripe sludge	6.90	45.1
Vegetable residues	28.2	19.7
Screenings	10.28	7.2

Effect of Lime.—Gas production per gram of volatile matter in the raw substances added to the different mixtures was calculated and is represented in Fig. 3. This was done in order to compare the ripe sludge and screenings mixture with the rest of the series. For the mixtures with the vegetable wastes, gas production figures are given for a 72-day period in addition to the 40-day period. The addition of lime to all the mixtures resulted in greater gas production with the exception of screenings and ripe sludge mixture. Gas production per gram of volatile matter in the screenings (unlimed series) was higher than that of the corresponding series with the fresh solids. This might have been expected, as the screenings are richer in gas-yielding carbonaceous materials than the fresh solids.

Total gas yield in 40 days from the mixture of vegetable waste and fresh solids in the unlimed series was lower than the corresponding series of the fresh solids and ripe sludge mixture. Only after 72 days did it reach the same level. In the limed series of fresh solids and vegetable residues gas production in 40 days was equal to that from the corresponding series of fresh solids without the vegetable residues. As can be seen in Table II this was obtained only with the addition of 5 times as much lime. The results obtained with the mixtures of vegetable residues and ripe sludge (Fig. 3) show that it is not sufficient to add high gas yielding carbonaceous substances indiscriminately. In spite of the excessive amounts of lime addition to correct the acidity (12 to 13 times as much as in the fresh solids and ripe sludge mixtures) gas production in 40 days was the lowest of all the limed mixtures and only in 72 days did it catch up with the rest. Since the vegetable waste digested when seeded with ripe sludge, but took far longer to reach the same degree of decomposition (decrease in the rate of decomposition) it is evident that more material was added than could be handled.

Volatile Matter Reduction.—In the same Fig. 3 is given the percentages reduction of volatile matter for these different mixtures in 40 and 60 days. These figures show the same general tendencies as previously deduced in the discussion of gas production. The reduction of volatile matter in the limed and unlimed series of ripe sludge and

fresh solids mixtures was equal for the 35-period, which in such a mixture is considered to be ample for complete digestion (see note 2). Complete being in the sense of ready to draw, producing good sludge without offensive odors, etc. The reduction in the mixture in which half of the fresh solids was replaced by vegetable waste was somewhat lower than that of fresh solids and ripe sludge mixture for the same period. When lime was added to this mixture, the percentage reduction of volatile matter was equal to that of limed fresh solids—ripe sludge mixture. The reduction of volatile matter was lowest of all for the unlimed and limed series of vegetable wastes and ripe sludge mixture. Keeping in mind that the percentage ash of the vegetable waste was nearly the same as the fresh solids, additional evidence is provided showing the retardation of decomposition under these conditions.

In Table II are given the figures of the amounts of lime added to the mixture per 100 gm. of raw material.

Table II.—Lime Added to the Different Mixtures Per 100 Grams of Dry Raw Material.

Mixture	Lime Added gm.
1. R. S. + F. S.	1.8
2. R. S. + F. S. + V. W.	7.7
3. R. S. + V. W.	24.8
4. R. S. + F. C. + Scr. 11.2%	2.6
5. R. S. + Scr.	2.1

(R. S. = Ripe Sludge; F. S. = Fresh Solids; V. W. = Vegetable Waste; Scr. = Screenings.)

About equal amounts of lime were necessary for the digestion of screenings and fresh solids. This is significant since it was expected that the digestion of screenings would give rise to higher acidity. Obviously, the nitrogenous substances in the feces are enough to counterbalance the carbonaceous materials.

Odors.—It is well known that odors from decomposing sewage solids come mainly from sulfur compounds. The offending substance might be hydrogen sulfide, mercaptans or some other intermediate decomposition product. It does not seem to be so well understood by sanitary engineers that odors are intensified in an acid medium. It is possible that this question has not been sufficiently emphasized. It seems that the reasons for intensification of odors are mainly three-fold.

1. Change of type of digestion.
2. Retardation of activities of certain organisms.
3. Evolution of H_2S and other volatile odoriferous substances.

(1) The change in type of digestion under acid conditions is not hypothetical, but there are numerous indications that in an acid medium intermediate decomposition products are produced which are not formed under alkaline conditions. These long and difficult studies will eventually be published, a beginning has already been made.[1]

(2) Certain organisms responsible for the decomposition of nitrogenous products, containing combined sulful, are retarded in their activities in an acid medium, and it seems especially those which attack the intermediate decomposition products of nitrogenous substances. The result is that these intermediate products remain longer and possibly accumulate in the supernatent liquid, thereby prolonging duration and intensity of odor.

(3) The acidity of the medium is produced from carbonaceous material, which when attacked forms organic acids as intermediate products which may remain or be further decomposed and quantities of CO_2 as end products. These organic acids decompose slower in an acid medium with an increase in intensity of acidity, while the CO_2 is partially retained by the liquid and partially goes off as a gas. Hydrogen sulfide is driven off in an acid medium and the H_2S produced as a product of decomposition is realsed from the liquid at an increased rate proportional to the increase in acidity of the liquid. When lime is added to such an acid medium the H_2S, which is acid in character, is retained by the alkaline material, reducing the quanity and intensity of the odors.

It is quite evident therefore, that increasing the amounts of carbonaceous material by the addition of vegetable waste, producing in turn larger quantities of acid materials, odors should be intensified. That this is precisely the case is demonstrated by the odors from the different mixtures employed in these experiments. In order to visibly show this we have made use of the following crude method of expressing the entensity of the odors. A zero means odor of ripe sludge (tarry); + is putrid; ++ is strong putrid odor; +++ is intense putrid odor:

	Unlimed			Limed						
No. of Mixture	1	2	3	4	5	6	7	8	9	10
Odor after 32 days	+	++	+++	+	0	+	++	++	+	0
Odor after 62 days	0	+	+++	0	0	0	+	+	0	0

To the unlimed mixtures 2 and 3 vegetable waste was added to ripe sludge and fresh solids, while mixtures 7 and 9 were similar but had received lime to neutralize the acidity. With increased amounts of carbonaceous matter (vegetable waste) the odors increased, but a remarkable reduction in odors took place when sufficient lime was present to cause a slight alkaline reaction (pH 7.4—7.6).

We have been calling attention to the fact that a good deal of odor troubles can be overcome by intelligent operation of tanks. Keeping the reaction of the material in a tank slightly alkaline is one of the means, which not only keeps down odors but also increases the general efficiency of the plant.

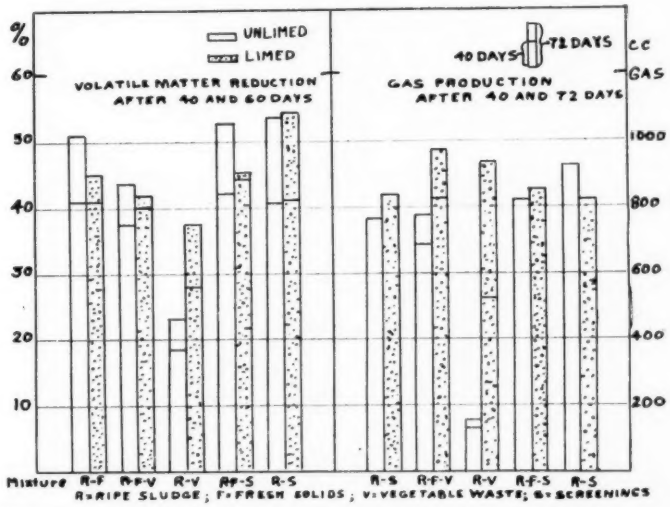


Fig. 3.—Percentage Volatile Matter Reduction and Gas Production per Gram Volatile Matter in the Raw Substances. (For Meaning of Letters and Ratios See Figs. 1 and 2.)

Discussion and Summary.—It is evident that digestion of vegetable waste is possible in treatment plants receiving domestic sewage, but it requires not only an increase in digestion capacity equivalent to the increase in weight of solids to be handled, but also a greater digestion capacity on account of the slower rate of digestion. Anaerobic digestion of vegetable wastes and possibly of garbage is possible, but takes longer time; probably due to the fact that the amounts of nitrogenous substances are low, and the production of acid substances is great. The low quantities of nitrogenous substances result in a poor nitrogen carbon relation, which affects the proper growth of organisms responsible for decomposition. Ordinarily, organisms active in the decomposition of mixed organic substances, like sewage solids, are depressed by acid conditions. An incorrect carbon-nitrogen ratio, result in an acid medium and odors are intensified. The acidity can be corrected by the addition of lime, but the quantities re-

[1] Journal Industrial & Engineering Chemistry, Jan., 1928.

quired are large. At present it does not seem that separate digestion of mixed carbonaceous vegetable matter is economical. But if sufficient sludge digestion capacity is available such vegetable waste can be decomposed readily in plants treating domestic sewage, without upsetting the digestion activities. There is no doubt that with intelligent control and sufficient capacity, vegetable waste can be handled, but further experiments will have to show the limits of such additions. Vegetable substances with higher nitrogen contents like bean and pea waste might conceivably digest at a faster rate when properly seeded than wastes low in nitrogen content. Experiments are now under way in our laboratory to determine the effects of particular vegetable wastes received from canning factories upon the digestion of sewage solids, and whether it is economically possible to digest them separately under different environmental conditions.

Caterpillar Tractor Co. Announces New Model

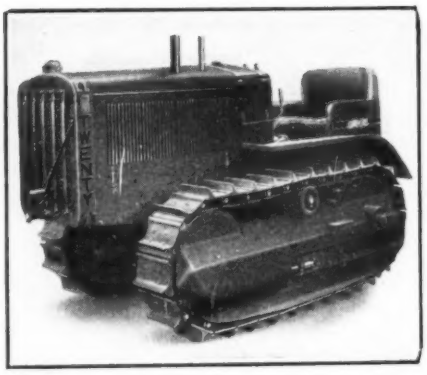
The Caterpillar Tractor Co., of San Leandro, Calif., and Peoria, Ill., announces a new model tractor designated as the "Caterpillar" Twenty. The new model takes its name from the fact that its rating is twenty horsepower at the drawbar.

The twenty is a new tractor in size, rating and price, built to fit into a line of bigger brothers, the thirty and the sixty, as well as the smaller 2-ton, and to supplement these models in agriculture, contracting, lumbering, municipal work and in industry, according to engineers of the company.

It represents the cumulative engineering experience of more than forty years of tractor manufacture to meet the demands of tractor users in practically every country in the world. Engineers of the Caterpillar Tractor Co. state that they spent two years in designing, building and testing the new model under the most adverse field conditions before finally putting it into production.

Following are the specifications of the new model: Engine—Bore, 4 in.; stroke, 5½ in.; 1,100 r.p.m. Valves—Exhaust, head diameter, 1 3/32 in.; stem diameter, 7/8 in.; inlet, head diameter, 1 3/32 in.; stem diameter, 7/8 in.; crank shaft, diameter, 2.50 in.; cam shaft, bearings, diameter, 2.50 in.; pistons, diameter, 4 in., length, 5.25 in., rings, ⅛ in.; piston pins, diameter, 1.50 in.; fan, blades, 6; fan diameter, 20 in.; brakes, drum diameter, 11⅝ in.; band with, 3 in.

Fuel, gasoline.—In countries where gasoline is unobtainable or where its price is unduly high in comparison with other locally obtainable fuels, distillate, kerosene, alcohol, etc., can be used. Information regarding the use of such



The New Caterpillar Twenty, a Tractor of Many Uses

fuels furnished on request. The fuel tank has a capacity of 22 gallons.

The flywheel clutch drives the upper transmission shaft through all-metal double universal connection. It has two friction surfaces, the clutch plates are 14 in. diameter, and the friction surface area is 115 sq. in.

The transmission is of the selective gear type, with three speeds forward and one reverse. Single reduction in all forward speeds.

The width of track shoe (standard) is 11 in. The height of the integral grouser is 2¼ in. The diameter of the track shoe bolts is ½ in., the diameter of the track pin is 1 7/8 in., and the diameter of the track pin bushings, 2 in. The grease pump has a capacity of 25 lb.

The tractor has a rated engine speed of 1,100 r.p.m., and a drawbar horsepower of 20., with a belt horsepower of 25.

The speeds furnished are low, 1.79 m. p. h., intermediate, 3.07 m. p. h., high, 4.67 m. p. h., and reverse, 2.26 m. p. h.

The dimensions are over-all length, 115.5 in.; over-all width, 61 in.; over-all height, 60.5 in.; tread, 42 in.; and ground clearance under transmission, 12 in. The height of the drawbar above ground is 15¾ in. The net weight is approximately 7,000 lb.

A variety of special equipment is provided for the new model to meet all special requirements of owners. Special track shoes may be ordered in place of the standard 11-in. shoes. A spark arrester offers maximum protection against possibilities of sparks coming from the exhaust. A front pull hook is available as it is often useful for pulling loads in reverse gear.

The lighting equipment includes powerful headlights, with brackets and necessary wiring. This equipment can be furnished applied at the plant, or boxed for field installation. Bracket bolt holes are tapped into radiator side plates and in the fenders at the rear of the tractor, to enable the owner to locate lights to suit his convenience. Current for the lighting system can be furnished either direct from a generator, or by a generator and storage battery system. For belt work, a stationary drive can be attached to the rear of the transmission case, this unit connecting directly with the upper transmission shaft. The new model develops 25 belt horsepower. A power take-off can be provided for use with various equipment that is designed to be operated, as well as pulled, by a tractor. The new model can be equipped with a power take-off at either the front or rear.

The summer top and cab equipment is of the quickly convertible type. The summer top consists of an angle iron frame and curved top over the driver's seat. This is easily converted into a completely enclosed cab by the addition of sides and doors or curtains.

An electric starter, with a floor button, starting motor and starter flywheel ring, can be installed. The company advises that this equipment be ordered attached at the plant; but starter ring shrunk upon the flywheel, together with motor and accessories, can be supplied for field installation. The use of an electric starter, of course, necessitates that the tractor also be equipped with generator and battery, which can be used both for starter and the lights.

Street plates can be furnished for conditions that make the use of a smooth track surface necessary or desirable. These plates bolt to the standard shoes and provide a flat ground contact without projecting grousers of bolt heads. The twenty can be equipped with a muffler on the exhaust. An odometer, which registers distance traveled in miles, can be fitted to the twenty to aid those tractor users who desire to keep accurate work or cost records. A special carburetor can be supplied when alcohol is used for fuel.

Mosquito Trap.—At the recent 15th annual meeting of the New Jersey Mosquito Extermination Association Dr. Thomas J. Headlee, of New Brunswick, chief entomologist of the New Jersey Agricultural Experiment Station, announced perfection of a "mosquito trap" used to discover breeding centers. The trap is a large can containing an electric light near the top. It is hung on a tree, and the mosquitoes, attracted by the light, crawl up inside through a wire passageway and cannot again find the entrance.

Sewer Systems in Kansas.—A total of 149 cities in Kansas have sewer systems according to statistics collected by the League of Kansas Municipalities. Of the 470 cities of the third class, 67 have sewer systems; 18 cities of the third class have installed sewer systems during the past two years. Two cities of the second class have installed sewer systems in the past two years, with a result that 71 cities of the second class are now sewered.

Important Developments During the Past Year in Highway Research

A Summary of the Reports Presented at the 7th Annual Meeting of the Highway Research Board

By A. C. ROSE

Associate Highway Engineer, U. S. Bureau of Public Roads

At the present time the Highway Research Board of the National Research Council has eight committee conducting research studies of various problems in the highway field. At the recent 7th annual meeting of the board some very interesting reports of the progress made in 1927 in these studies were presented. An interesting summary of these reports is given in the January Public Roads, the official publication of the U. S. Bureau of Public Roads, by A. C. Rose, an Engineer of the Bureau. The main points in Mr. Rose's summary are given herewith.

AUSTIN B. FLETCHER, chairman of the committee on causes and prevention of highway accidents, in his introductory remarks, preliminary to the reading of the detailed papers by the six members of his committee, stated that motor-vehicle accidents were increasing at the rate of 5 per cent a year, and for this reason it did not seem necessary to emphasize the need of highway-safety precautions. In order to make the investigations of the committee as comprehensive as possible, there were included in its membership not only highway engineers but also a psychologist, a physicist, and an automobile manufacturer.

Motor Vehicle Accidents.—S. J. Williams, director of the public safety division of the National Safety Council, a member of the committee, estimated motor vehicle fatalities in 1926 at 23,000, and stated that they are growing at the rate of 1,000 a year. In the cities two-thirds or more of the accidents involve pedestrians, while on the rural roads the corresponding proportion is one-half. The speaker stressed the need for more accurate information concerning the causes of accidents since, unfortunately, only about six States require systematic accident reports and statistics. To supply this deficiency, Mr. Williams advocated the adoption of a standard reporting system that would consist of: (1) An individual report card, and (2) a tabulation form for summarizing the cards monthly and annually. For small municipalities, tally sheets would be used, and for large States the punch card system would be more economical.

In trying to arrive at the causes of accidents Mr. Williams believes it is a mistake to try primarily to fix the personal responsibility. He thinks it a much better plan to collect data as to the circumstances or facts in each case in order to eliminate the element of personal judgment. He concludes, however, that the most refined accident statistics are at best only the first step in solving the problem, the final solution of which depends upon the application of remedial measures based upon a scientific study of the accident statistics.

M. G. Lloyd, chief of the safety section of the United States Bureau of Standards, delivered a paper on the standardization of motor vehicle equipment as a means of reducing the accident risk. He believes that headlight devices should be regulated by the States and not by Federal or municipal authorities.

Motor Vehicle Lights.—The general specifications now in use are those adopted by the Illuminating Engineering Society in 1920, and revised in 1922. These have also been adopted by the engineering standards committee. There are two basic ideas included in these specifications:

1. An attempt to avoid throwing excessive light into the eyes of the driver of an approaching automobile.

2. An attempt to throw the maximum amount of light upon the highway.

The defect in the present regulations is that while they require adequate equipment they do not include sufficiently drastic regulations concerning the maintenance of the apparatus in proper adjustment. This deficiency, said Doctor Lloyd, should be remedied. The depressible beams of light, now being developed commercially, involve legal complications because they are in conflict with the existing laws based upon fixed beam lights. The adjustment of headlights involves two factors: (1) Proper aiming, and (2) proper focusing.

The speaker continued with a discussion of tail lights and rear signaling lamps and concluded with a reference to the new code which had been prepared for testing and regulating brakes. With the four-wheel brakes in use, Doctor Lloyd believes the requirements relative to stopping distance could be made more severe.

Psychology a Factor in Accident Prevention.—In delivering the third section of the accident report, Knight Dunlap, professor of experimental psychology at Johns Hopkins University, said that psychologists were interested in the sense of preception and the formation of habits. It is important in reducing accidents to develop safety habits which become instinctive. The time lost in thinking of the action required is often critical. Unnecessary and misplaced signs cause accidents not only at the point at which they are situated but also at other locations, because they breed a contempt of warning signs which leads to the development of unsafe driving habits.

In commenting upon the proper colors for luminous signals and fixed signs, Doctor Dunlap stated that the entire retina of the eye is not equally susceptible to color. For all practical purposes, the rapid discernment of color is limited to the central vision. Yellow and blue are excellent colors for this purpose, but the generally used red and green are tolerably satisfactory. In order to improve the colors now generally accepted, the green should be made as blue as possible, and then, if the cautionary yellow color could be abandoned, it would be better to shade the present red into an orange-red color.

With regard to refusing licenses to color-blind people, the speaker said it is impracticable to solve the problem by refusing to issue licenses. Color-blind persons with some preliminary training can pass a casual examination and only a thorough investigation by a highly trained physician or psychologist can detect vision defective in regard to color. Furthermore, normal persons, when under the strain of an examination, have their color sense sometimes temporarily disturbed.

Motor Truck Accidents.—John C. Long, secretary of the street-traffic committee of the National Automobile Chamber of Commerce, gave a report of a study limited to motor-truck accidents in Hartford, Conn., during the period of January 1 to 30, 1927. All accidents involving property damage of $10 or more were included. The conclusions show that drivers were at fault 57 per cent of the cases. Difficulty was experienced in obtaining information

because of the fear of unfavorable publicity on the part of the motor-truck owners. This difficulty was removed when it was explained that the aim was not to fix personal responsibility but to determine the causes of accidents and to reduce these by adequate instruction in a motor-truck driver's school.

A. N. Johnson, dean of the University of Maryland, showed lantern slides giving the results of a method used for measuring the relative efficiency of traffic flow through street intersections under various conditions of control, such as traffic lights and police officers. The speaker believed that the flow of traffic through street intersections is a fundamental consideration both with respect to safety and to the speeding up of traffic.

Grade Crossing Accidents.—W. G. Eliot, 3d, of the Bureau of Public Roads, concluded the accident reports with a statistical study of the number of grade-crossing accidents in the United States. The data indicated that grade crossings are responsible for 10 per cent of all motor-vehicle fatalities, but only 1 per cent of the total injuries. The number of rural and urban grade-crossing accidents are almost equal, but 65 per cent of the fatalities are rural. One explanation of this is the slower speed of trains in cities. Mr. Eliot estimates that only 40 per cent of traffic accidents of all kinds occur on rural highways, and that grade-crossing accidents represent 16 per cent of the total on rural roads.

Studies Relating to Vehicle Operation.—Professor Agg, the chairman of the committee on economic theory of highway improvement, in summarizing the reports of individual members of the committee, stated that the paper on the measurement of tractive resistance, although not perhaps a final report, may be considered to represent the completion of the project. Roughly, the report dealt with four factors: (1) Rolling resistance, influenced by the condition and kind of tire; (2) impact, as affected by the distortion or character of the road surface; (3) air resistance; and (4) the coefficient of friction between the tire and the roadway surface.

Relative to the progress report on the cost of operation of automobiles, Professor Agg stated that the records show lower costs per mile as compared with figures obtained four or five years ago. This was believed to be caused by the greater distance traveled annually by the average driver and also to the improved character of motor vehicles.

It was announced that the report on the effect of roadway surface on tire wear was not ready for presentation but that it was expected to be completed in time to be made a part of the printed proceedings.

Professor Agg referred to studies his committee has made on the contribution of common-carrier busses to State-road funds. The information so far tabulated had been obtained from the records of the public service commissions of Michigan and Iowa. In Iowa the contribution of the motor bus per ton-mile is decidedly greater than that of privately-owned automobiles. In Michigan the reverse is true. The committee will attempt to determine the proper contribution.

Wind Resistance to Motor Vehicles.—L. E. Conrad of Kansas State Agricultural College delivered his report on wind resistance to motor vehicles. In summarizing available information on the subject, he pointed out that only three investigations are known to have been made in the United States, those of: (1) The United States Bureau of Standards; (2) the engineering experiment station of Kansas Agricultural College; and (3) the engineering experiment station of Iowa State College. Some work has also been done along similar lines in Germany.

Professor Conrad concludes that for a straight head wind the resistance for ordinary passenger cars may be considered as $0.0025V^2$ pounds per square foot of projected area. In this formula V is equal to the velocity of the automobile in miles per hour. He believes that an even exponent of V will serve as well as a fractional one for all practical purposes. Studies are to be continued on the effect of side and quartering wind.

Tractive Resistance.—H. B. Shaw, of North Carolina State College, gave a résumé of research on tractive resistance. An attempt is being made to formulate a practical theory based upon the results of outstanding studies. As an interesting side light he recalled that Sir Isaac Newton, years ago, developed theoretically a value for air resistance that has since been confirmed experimentally. The present experiments indicate that tire displacement resistance decreases with increased air pressure in the tire which results from the heating which takes place when a vehicle is in motion. Tire displacement has been found to increase at a greater rate than the increase of the weight on the tire.

Structural Design of Road Studied.—A. T. Goldbeck, of the National Crushed Stone Association, chairman of the committee on structural design of roads, because of the limited time, summarized the reports of the members of his committee. These papers covered 19 subjects. With regard to the loads on highways the speaker stated that with the same total load the rear wheels of four-wheel trucks transmit twice as much load to the pavement as either pair of rear wheels of the six-wheel truck.

The report on subgrade studies outlined methods of soil identification from known proportions of the separates of sand, silt, and clay. The slaking value test was mentioned as indicating the susceptibility of soil to erosion. A simple precolation test was considered to be adequate to determine those soils which might be drained with tile. The report continued with a discussion of the behavior of subgrade soils when subjected to various moisture conditions. Granular subbases were mentioned as an efficacious method of compensating undersirable subgrades. The studies of landslides, and the sand-clay, gravel, and top soil surfaces of the Southern States were outlined.

Rule of Thumb for Bituminous Macadam.—A rough practical rule given for the construction of bituminous macadam surfaces was that the depth of the surface course in inches should be equal to the maximum size of stone in the surface course, and the number of gallons of bitumen per square yard of surface might be estimated at the same numerical figure. Thus for a 1½ in. surface course, the maximum size of stone would be 1½ in., and there would be required 1½ gal. of bitumen per square yard.

With respect to the design of concrete pavements, the speaker stated that this is affected by the character and condition of the subgrade, and that the latter must be evaluated in order to make possible a more accurate cross section. The maximum wheel load is now recognized as causing the stress for which the pavements must be designed. There is a noticeable tendency on the part of highway engineers to reduce the size of concrete pavement slabs with longitudinal and transverse joints.

Mr. Goldbeck concluded his summary with comments concerning reinforcing and curing of concrete pavements, and methods of constructing brick pavements.

In a general discussion of the report of the committee on structural design of roads, C. H. Moorefield, State highway engineer of South Carolina, stressed the importance of considering the subgrade and emphasized the need of further knowledge of subgrade soils and their behavior as a prerequisite to adequate pavement design.

Character and Use of Road Materials.—The report of the committee on character and use of road materials was presented by the chairman—H. S. Mattimore of the Pennsylvania State highway department. The paper discussed six factors in the control of the construction of concrete pavements: (1) Retesting of cement stored over three months; (2) fine aggregate; (3) coarse aggregate; (4) proportioning of materials; (5) curing the finished pavement; and (6) tests of the finished pavement.

The quantity of Portland cement used, said the speaker, should be carefully checked at the plant, on the job, and by counting the empty sacks. With regard to fine aggregates, uniformity, durability, and a uniform degree of

hardness and toughness, are desirable. Stone screenings contain too much dust for satisfactory use as concrete aggregate. They also make it more difficult to finish the pavement. Seven theories of designing concrete mixtures were discussed.

Discussing tests of finished pavements, Mr. Mattimore stated that three methods are in general use; (1) A compression test on specimens made and partially cured in the field; (2) a compression test on cores drilled from the finished pavement; and (3) a transverse beam test on specimens made and cured in the field. Although the prevailing practice has been to keep concrete pavements closed for three weeks, the indications are that it is better practice to vary the time according to the results of tests. Up to the present time the procedure for making the field transverse test has never been standardized so as to produce comparable results by different observers.

P. J. Freeman of the Allegheny County department of public works, in Pennsylvania, discussed the practical aspects of Mr. Mattimore's report. He believed that not enough attention has been paid to the weight of the bagged cement at the mill. In some cases observations show a difference of 13 per cent between the high and low weight. Careful consideration should be given the proposed plan of proportioning the cement by weight. With regard to the bulking of sand, it is not a difficult matter to determine the percentage of moisture in the field. The weighing and inundation methods seemed to be the simplest yet devised.

Referring to the committee's recommendations relative to the sampling of coarse aggregate, he differentiated between the purposes of the sampling. If it is desired to determine the average quality of coarse aggregate, say on a barge, then the suggested method is satisfactory, but where it is desired to determine whether one end of a pile is badly segregated, then a method other than that proposed by the committee would have to be used.

With reference to sampling, proportioning and design of concrete mixtures, Mr. Freeman believes that more attention should be given to prevention of segregation of aggregate. To accomplish this, flat rather than conical piles should be used.

Referring to the proposed method of proportioning concrete by combining definite weights of the several constituent materials, the speaker believes that nothing more elaborate is being advocated than what has been in use for years in the construction of bituminous pavements.

Mr. Freeman emphasized the urgency of placing wet burlap on the concrete as soon as possible for curing. He fears that too much time is being spent on finishing. Stating also that excessive checking is caused by too early belting, he believes there is a happy medium of time and that more research is needed concerning this factor.

Testing Finished Pavement.—Calling attention to the present methods of testing the finished pavement, he stated his belief that it is illogical to close pavements for a standard time of three weeks in July and November, because of the widely different weather conditions. Some of the concrete pavements in Allegheny County, laid in the summer, have been opened successfully in three days, while other projects, built late in the fall, have not been opened until the following spring. For the traffic in Allegheny County Mr. Freeman believes that a modulus of rupture of 500 pounds per square inch, as determined by the beam test, gives an ample factor of safety.

D. A. Abrams, acting as presiding officer at the morning session on December 2, introduced A. J. Brosseau, who spoke on highway finance. The speaker analyzed the aggregate Federal expenditures and showed the relation thereto of the Federal highway disbursements. The Federal road expenditures were shown to be less than 8 per cent of the entire rural highway bill. Mr. Brosseau believes that our national highway finance structure is sound, necessary, and profitable.

Use of Gas Tax on City Streets.—In discussing Mr. Brosseau's paper, Professor Agg called attention to a new problem that is arising in highway finance. His studies indicate that, in some instances, municipalities are requesting that a portion of the gasoline tax be prorated to them for the construction and maintenance of the city streets. The city argument is that their motor-vehicle users are paying for a large part of the cost of rural roads, for which they are not receiving an equitable return. Professor Agg pointed out that if the gasoline taxes are returned to the cities the tendency will be to dissipate the funds which are now being used through a central State agency to secure maximum results on the rural roads. In discusing this point, J. G. McKay, of the Bureau of Public Roads, presented some conclusive arguments. He stated that traffic surveys of the bureau indicate that 80 to 90 per cent of the rural-road traffic and the bulk of the heavy-truck traffic originate within city limits. It is, therefore, logical that the city motor-vehicle owners should bear the bulk of the cost of the rural roads. He also added that there is no reason why the rural land owner should pay for any considerable portion of the through trunk roads because land values in the strictly rural areas are not increased to a large extent by this kind of road development.

Highway Traffic.—G. E. Hamlin, of the Connecticut State Highway Commission, as chairman, introduced the individual reports of the committee on highway traffic. He stated that highways should be classified with respect to their weight-carrying capacity, and that there is an urgent need for establishing adequate rights of way in congested rural areas. Computations were presented showing that the maximum capacity of a single-lane road amounting to 1,969 motor vehicles per hour occurs at a speed of 22 miles. The maximum capacity of a two-lane road with mixed speeds is somewhat less than twice that of the single-lane road. He outlined the effect of overcrowding a two-lane road and showed the magnitude of the time losses at grade crossings and in small villages. The precautionary stop of a motor vehicle at a grade crossing was said to average seven and one-half to eight seconds. A comparison was made of the time consumed on by-pass or belt routes around centers of population, as contrasted with through roads. Forecasting the future development of traffic the speaker saw an increase in the use of six-wheel trucks.

J. G. McKay, of the Bureau of Public Roads, as a member of the committee, gave a description of the new traffic-flow recording device now being used by the bureau in the traffic studies in the Cleveland metropolitan area. An attempt is being made to determine the traffic capacity of various widths of roads as well as the preferential speed for various densities of traffic.

A. N. Johnson showed lantern slides of the airplane pictures taken during the traffic study on the Washington-Baltimore boulevard. The pictures were taken at an elevation of 3,600 ft. and showed a strip of land 2,000 ft. on each side of the road.

H. J. Kirk of the Ohio State Highway Department gave a description of a traffic speed recorder which had recently been manufactured by a firm in Dayton, Ohio. The variations in speed of a motor vehicle are shown by variation in the slope of a graph made upon paper mounted upon revolving cylinders. The device has been used on delivery wagons to determine if drivers are making the rounds on a regular schedule and may be useful in traffic flow studies.

Results of Traffic Studies.—Discussing the report of the committee on highway traffic, W. G. Sloan, State highway engineer of New Jersey, stated that traffic studies are vital to the solution of the highway transportation problem. Basing his remarks upon traffic surveys made in New Jersey, he estimates a 200 per cent increase in traffic in 1932, as compared with 1923. Traffic surveys and gasoline consumed indicate that the annual mileage traveled by automobiles is increasing more rapidly than the motor-vehicle registration. A graph prepared by the New Jersey department shows 1,600 vehicles as the maximum capacity of a single-traffic lane at 22 miles per hour, while the curve of the committee indicates 1,969 vehicles. The speaker em-

phasized the economic loss caused by the interruption to the flow of traffic at grade crossings in addition to the loss due to accidents and fatalities.

Selling Research to the Public.—Maurice Holland, director of the division of engineering and industrial research, gave an address on the subject of selling research to the public, or, as he expressed it, making the public research conscious. There are at present 1,000 research laboratories in the country and this is an increase of almost 100 per cent in six years. Stating that a man's success in business is in direct proportion to his ability to sell his services, he believes that until research can be translated into the language of the man on the street, we can not expect to obtain general attention. Lindbergh's flight was an example of the popularization of science, and today, as a result, 117 airplane factories in this country are running behind their production schedule.

The speaker said that the results of research must be made apparent and that proper showmanship is necessary to popularize the message. He referred to Pasteur as a master showman in reporting his studies to the French Academy, before whom he demonstrated the effects of living anthrax germs.

Speaking of the four mediums for reaching the public, he said that with the spoken word, in lecture form, only the attention of a few hundred people at best could be held. With articles written in trade journals 6,000 to 60,000 people could be reached. He mentioned the motion picture as an untired medium from a research standpoint, and added that one weekly news reel reaches 12,000,000. The speaker believes that radio the least expensive and most effective means of disseminating public information. One broadcasting station in New York City reaches four or five million people nightly.

Low-Cost Road Investigation.—At the afternoon session C. N. Conner, chairman of the committee on low-cost road improvement, gave a detailed study of the construction practices determined by field inspections in 23 States. The work of the committee has been financed by the American Road Builders' Association and T. Coleman du Pont. The purpose of the study is to assist those engaged in the construction of this type of road. Studies of typical cross-sections in 26 States were shown with lantern slides. The low-cost roads studied have an average traffic of 600 and a maximum of 1,500 per day. The survey has been limited to untreated surfaces costing less than $10,000 a mile and surface treatments costing less than $6,000 a mile. The report presented was a digest of the full report which contains 60,000 words.

H. J. Kirk, of the Ohio State Highway Department, followed with a discussion of untreated traffic-bound types of low-cost roads.

C. A. Hogentogler, of the Bureau of Public Roads, presented a report on subgrades and soils, indicating their relation to the low-cost road problem. The subgrade soil observer attempts to determine where rigid or flexible road surfaces may be laid. The surest subgrade treatment was believed to consist of a granular subbase compacted under traffic.

N. S. Anderson, of the South Carolina State Highway Department, described the surface treatment of main highways with topsoil and selected earth. For bituminous surface treatment, the base should be sufficiently porous to permit the tar prime coat to penetrate one-fourth inch. Excessive mica in the material makes the base unstable.

Cost of Untreated Surfaces.—W. R. Neel, of the Georgia State Highway Department, described untreated surfaces of sand-clay, chert, and gravel. He discussed the materials, methods of construction, cost of construction and maintenance, serviceability and salvage value. The average cost of sand-clay roads in Georgia is $1.650 a mile and the average annual maintenance costs $170 per mile. These roads are serviceable for 400 vehicles a day or less. For this amount of traffic the annual loss of surfacing material is one inch of depth. The sand-clay road is of great value as the first step in stage construction for stabilizing subgrades.

Chert construction costs up to $7,000 a mile and carries up to 1,000 vehicles a day. The average annual loss in depth is one-half inch.

On gravel roads, the traffic should not exceed 1,000 vehicles a day. The average annual maintenance cost is $200 a mile. The average annual loss in depth is ¾ in.

The Georgia State Highway Department has co-operated with Doctor Strahan, of the University of Georgia, in an extensive study of low-cost roads which has recently been completed.

J. T. Pauls, of the Bureau of Public Roads, presented a report on mixed-in-place surfaces, using local topsoil and gravel aggregates and tar or asphalt. The maintenence costs of untreated roads are excessive for a traffic greater than four to five hundred vehicles a day and resort is being had to various bituminous materials. Preliminary studies have been carried on in several States. To obtain good results with this type, correct maintenance is as necessary as first-class construction.

Mixed-in-Place Surface.—V. R. Burton, of Michigan, presented a paper on mixed-in-place surfaces of stone or gravel and fuel oil, prepared by C. L. McKesson, of the California State Highway Commission. This paper was in the nature of a discussion of Mr. Conner's paper. Mr. McKesson believes that untreated rock and gravel surfaces can not be justifiably termed low-cost roads when all the dependent costs are considered, such as maintenance, replacement, interest on first cost, excessive tire wear, motor-vehicle depreciation, and gasoline expenditures. Bituminous treatments according to recent California and Oregon practice are believed to so reduce these costs that the resulting surface might be classed as a low-cost road. Mr. McKesson had just returned from a trip abroad and it is his impression that European highway engineers agree that untreated gravel or stone roads are no longer economical.

B. E. Gray, of the West Virginia State Road Commission, illustrated his paper on the use of soft stone in the construction of puddle macadam with a number of lantern slides. The construction of the soft sandstone surfaces was said to range in cost between water-bound and penetration macadam. The annual maintenance costs, for traffic not exceeding 800 vehicles per day, does not exceed $200 to $300 per mile.

W. A. Van Duzer, of the Pennsylvania State Highway Department, discussed maintenance methods and equipment, referring to the maintenance organization of his State.

Traffic Capacity and Service of Low Cost Roads.—J. G. McKay, chief of the division of highway transportation and economics of the Bureau of Public Roads, presented a paper on traffic capacity and service of low-cost roads. He stated that the life costs of low, middle, and high-class surfaces must be determined before an intelligent selection of types may be made. Referring to the large mileage of low-type roads in the country, he stated that traffic studies of the bureau indicate that even in the densely populated State of Ohio, 70 per cent of the State highway system carries less than 600 vehicles a day. In both Pennsylvania and Vermont, 70 per cent of the primary road systems show an average daily traffic of 600 vehicles or less. With regard to the maximum wheel loads of trucks, the speaker believes that a 7,500-lb. load per wheel will cover the maximum loading on 75 per cent of the State systems. Less than 1 per cent of the Pennsylvania State highway system carries wheel loads in excess of 9,000-lb.

Grade Crossing Accidents.—The December issue of California Highways and Public Works reports an interesting analysis of grade crossing accidents on twenty-four railroads in California for the period from January 1, 1925 to May 10, 1927. The analysis was made by the State Railroad Commission. The 2,251 accidents analyzed were as follows: On crossings protected by crossing signs, 946; by wigwags, 654; by human flagmen, 290; by overhead crossing signs, 293; by gates, 34; by crossing bells, 34. These 2,251 accidents resulted in 297 persons being killed and 1,054 injured. Porperty damage only occurred in 1,360 accidents.

An Unusual Water Works

Water Treatment Plant at the Philips' Glow Lamp Works at Eindhoven, Holland

By DR. WILLEM RUDOLFS

During September, 1927, the writer had an opportunity to visit the water works of the Philips' Glow Lamp factories at Eindhoven, Holland. This water works plant is one of the best and most modern on the continent and several features of it seemed of sufficient interest to warrant a brief description of the plant and the results obtained.

The plant is located in the Province of Brabant and was designed by S. Lindeman, Chief Engineer of the "Inbulin" Engineering Bureau at the Hague. Operation of the plant is under the direction of H. Furstner, engineer in charge.

Description of Plant.—The nature of the products manufactured by the Philips' Glow Lamp Works demands pure water and only small quantities of CO_2, traces of iron and no manganese can be tolerated. The total water consumption amounts to 2.1 million gallons daily and is supplied by 42 deep driven wells, alternatingly 120 and 240 ft. deep with a distance between them of 60 ft. The plant consists of a contact basin, two settling tanks, two filters, aerators, pump room, clear water well and storage tower. The building covering the entire plant is constructed of brick and divided into three parts (Fig. 1) with pump room attached. The highest building contains the aerators in the upper story and the windows are closed with shutters and fine screens so that sufficient air circulation is provided for. No troubles are encountered during the winter on account of the moderate and even temperatures.

Treatment.—The normal capacity of the plant is 600 cu. meters per hour (158,400 gal.) and can be increased to 1,000 cu. meters (264,000 gal. per hour) which corresponds to the capacity of the clear well. Three low and three high pressure pumps, all automatic (Fig. 2) placed in a tiled, spotless pump room serve for all the necessary pumping. Attention is drawn to the arrangement of pumps, lighting and almost entire absence of visible wiring. Whenever wires or pipe lines are against the walls or ceilng they are placed in such a way along ledges or ceiling as not to disturb the general effect of space, neatness and efficiency.

The remote control panel built into the well (Fig. 3) occupies a minimum of space. A door next to the panel leads into the work room for the operator-mechanic where the back of the panel is exposed and easy to get at. On the left section of the panel the dials and switches of the vacuum pump and compressors are placed, next the raw water pumps and third the pure water pumps. Venturi meters for raw and pure water occupy the last two sections.

Aeration.—For removal of carbondioxide the water is aerated before filtration. There are six separate aeration units in one room which are independent of each other (Fig. 4). For spraying a special type of spray jet is used which is highly satisfactory. These nozzles consist of more or less U-

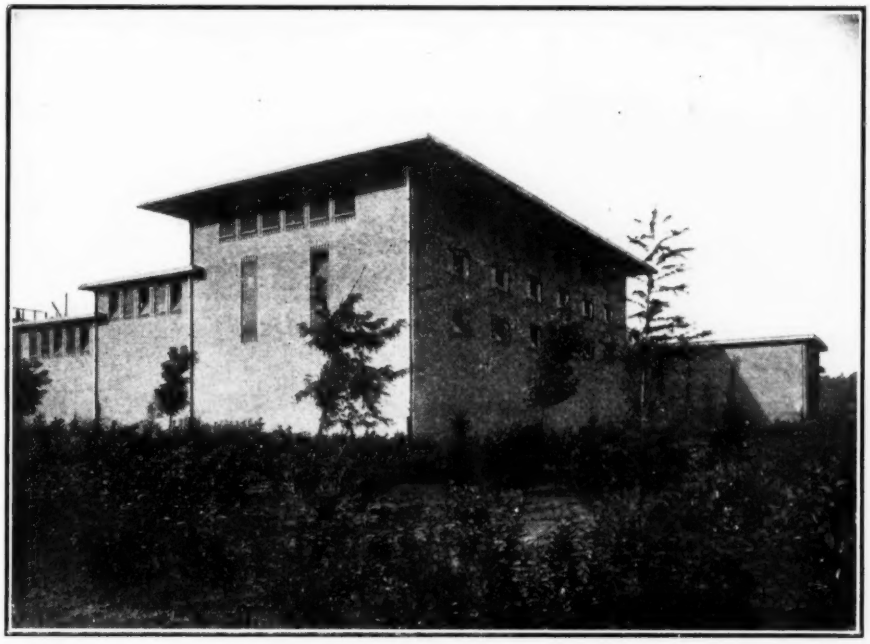


Fig. 1—Entire Water Treatment Plant. Note the Overhanging Roof Which Protects the Shuttered Windows from Rains

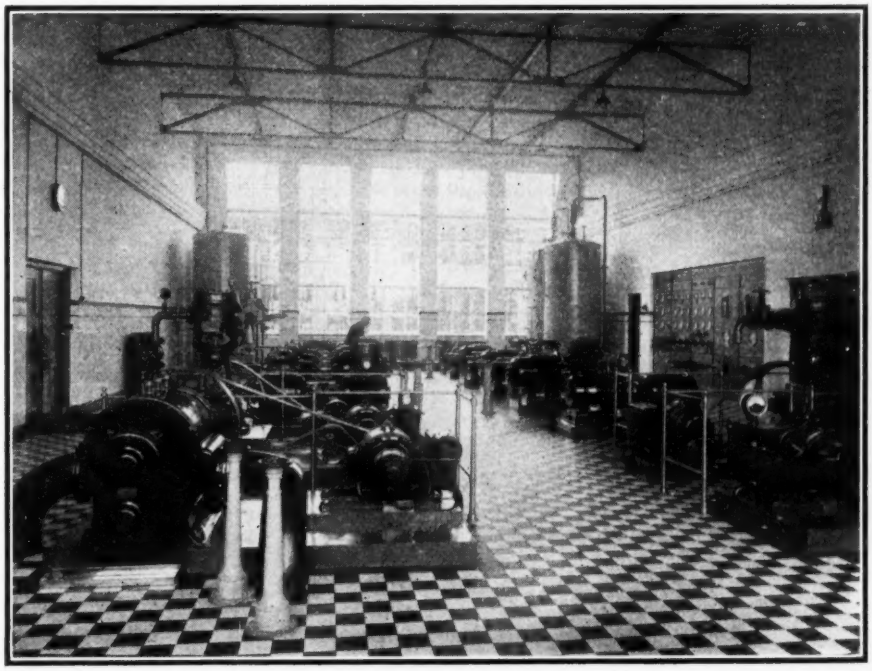


Fig. 2—Pump Room. The Proverbial Spotlessness of the Hollanders Is Quite Apparent. Centrifugal Motor 1450 r.p.m.

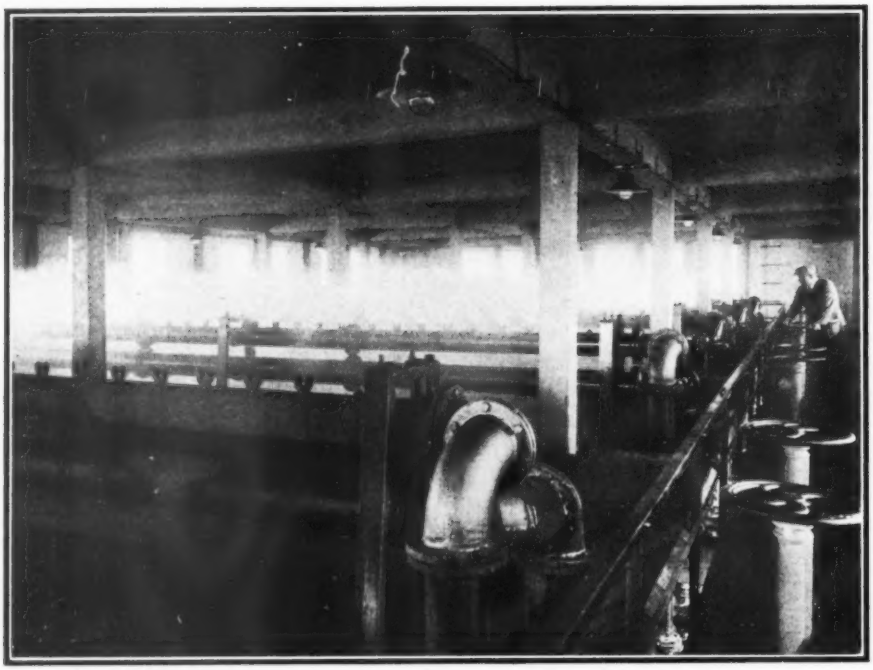


Fig. 4—Aeration Device. Six Independent Aeration Units, One of Which Is Shut Off. The Type of Nozzle Used Can Be Seen

shaped pieces of pipe screwed directly into the feed pipe; the two outlets of the nozzles are so placed that the streams of water hit each other, with the result that the water streams are broken up, producing a cloud of small drops. The water falls on filter beds, filled 8 ft. deep with crushed lava. Crushed lava seems to be a better filter medium than crushed rock on account of the irregular surface of the pieces. The surface of the independent units is 215 sq. ft. and filters with a velocity of 5 meter/ hour (16.4 ft. per hr.) The water then goes to a sand filter about 30 in. deep, 268 ft. square with a filtering velocity of 13 ft. per hour. In this process the CO_2 is reduced from 20-25 p.p.m. to 2-4 p.p.m. while the iron is removed from 2-3 p.p.m. to 0.1 p.p.m. Between the first and second set of filters (Fig. 5) potassium permanganate is added to remove the manganese. During the aeration and first filtration process not all the iron is removed, because it has been found that the removal of manganese (0.3-0.4 p.p.m.) is easier and more complete when small quantities of iron are present. The KMn 04 takes out the last traces of iron and the manganese comes out with it.

Cleaning of Filters.—Cleaning of filters is at present practiced about once a week, and it is expected that when the plant is at full capacity the filters must be cleaned twice a week. The filters are cleaned by applying air under pressure from the bottom, followed by wash-water and finally a mixture of air and water.

Cost of Treatment.—The whole plant, except the outside walls, is built from reinforced concrete. All instruments, piping, etc., was bought, but the installation was made by the Company itself. The whole installation (pumps, filters, etc.) is operated by one man (3 men on 8-hour shifts) while the engineer in charge makes the necessary daily control tests. The total cost of treatment, including electric current, labor, interest, depreciation and chemicals is from 2 to 2¼ cts. per cu. meter water or from 7.6 to 8.6 cts. per 1,000 gal.

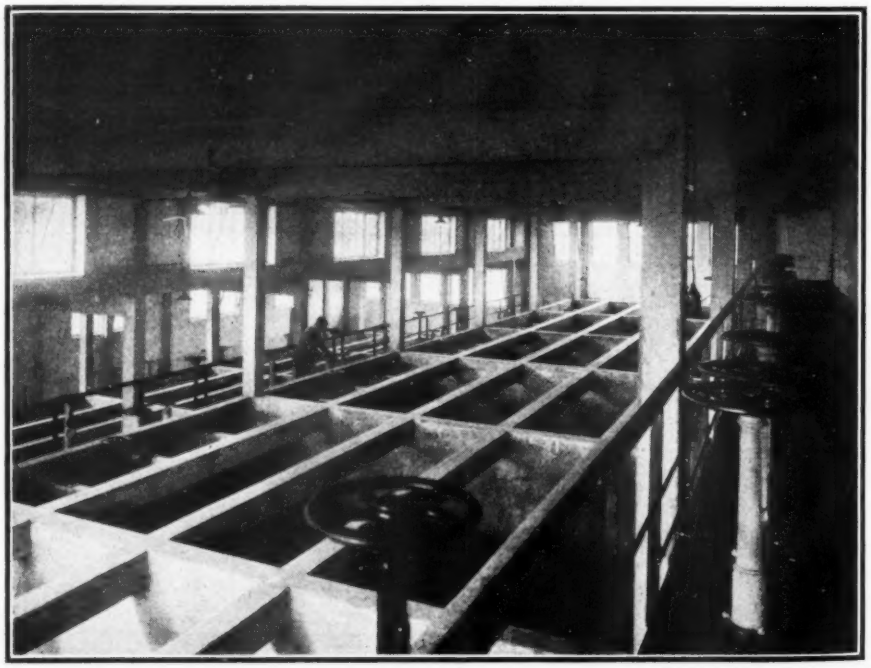


Fig. 5—Settling Basins and Filters. Again Six Independent Units for Each of the Two Filters. Detention Period About One Hour

Acknowledgment.—I am indebted to Mr. De Broekert, Technical Manager of the Philips' Glow Lamp Works, for permission to visit the plant and for use of the data; and to Mr. Furstner, Engineer in charge, for supplying me with the pictures.

New Sewage Treatment Plant for Dayton, O.—The new Dayton plant, plans for which were approved a short time ago by the State Department of Health, is designed for a population of 262,000 and an average daily flow of 26 million gallons. The sewage is pumped to the plant from the Broadway pumping station below the city. Essential features of the plant are the detritus tanks for combination grit and grease removal, grit chambers and fine screens for the detritus, incinerator for screenings and gease, and two-story settling tanks. The plant to be installed at this time consists of only primary treatment devices; secondary treatment devices are to be installed later when stream conditions require. Metcalf & Eddy, Consulting Engineers of Boston, prepared the plans and will supervise construction.

City Has Had Only Three Water Works Superintendents in 45 Years.—During the 45 years that the water works of Madison, Wis., have been in operation there have been only three full time superintendents, who have served for a total of 40 years. During the other 5 years the city engineers or a member of the water department acted as superintendent.

Clarification of the Catskill Water Supply of New York City

How Large Volume of Water was Clarified by Coagulation and Sedimentation

By WILLIAM W. BRUSH

Chief Engineer, Bureau of Water Supply, Department of Water Supply, Gas and Electricity of New York City

The Catskill water supply system was brought into general use for the city of New York early in 1917, and for nearly 10 years the water as delivered to the city was low enough in turbidity to make clarification treatment unnecessary. In December, 1925, a combination of very low storage reservoir level with a flood flow runoff raised the turbidity to such an extent that an alum and soda ash treatment was required which was continued for nearly 6 months. The method of introduction of the alum and soda ash, and the subsequent removal of the alum and turbidity are of particular interest due to the plan followed, the results secured, and the very large volume of water treated. An interesting account was given by Mr. Brush in a paper presented at the New England Water Works Association, an abstract of which is given herewith.—The Editors.

THE Gilboa dam, which forms the Schoharie reservoir, was first available for storage of water in July, 1926. On Nov. 15-16 the heaviest flow recorded in over 20 years was caused by a rainfall that averaged 3.63 in. in the Schoharie and 4.37 in. in the Esopus watershed, and was probably about 10 in. at points along the divide between the two watersheds where clay banks were most numerous. At the time of the storm the Schoharie reservoir was practically empty and the Esopus reservoir contents were at 18,847 m.g., which was virtually the lowest point recorded since before 1917 when the Catskill system was first used. The Schoharie reservoir raised 52 ft. in one day representing a gain in contents of 11,220 m. g., and in three days the contents of the west basin of the Ashokan reservoir increased from 12,059 m. g. to 28,701 m. g. The water was brick red in color and showed a turbidity of about 120 p.p.m. The draft was changed to the east basin where the water was clear, but by Dec. 8th this clear water was exhausted and simultaneously turbid water began to flow over into the east basin. Under these conditions turbid water had to be delivered into the aqueduct.

Condition of the Turbid Water.—Laboratory tests of the turbid water showed the following turbidity:

	Turpidity in p.p.m.
Water when collected.....	100
Water standing 1 and 2 days.....	80
Water standing 3 and 4 days.....	40
Water standing 5 to 16 days.....	20

When turbid water filled the Ashokan reservoir on previous occasions the maximum turbidity was about 30 p.p.m., which was reduced to below 10 p.p.m., before the water was drawn from the reservoir, the latter figure being the maximum turbidity at which it has been considered reasonable to deliver water to the consumer. Water with a turbidity of 10 p.p.m. could be used by passing it through Kensico reservoir. A microscopic examination of the water showed that the clay particles were about one-half the size of bacteria, the diameters being about 0.0002 to 0.001 m.m. According to a table in

Table I.—Weekly Average Temperature and Turbidity of Water in East and West Basins of Ashokan Reservoir from November, 1926, to June, 1927

Week Ended	Mean depth of water in Reservoir (feet above available bottom)		TEMPERATURE- F°						TURBIDITY - p.p.m. Silica					
			West Basin			East Basin			West Basin			East Basin		
	West Basin	East Basin	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
1926														
Nov. 6	43.1	22.8	45	45	46	47	47	47	3	3	3	4	4	4
Nov. 13	43.6	23.1	44	44	44	44	44	44	6	6	8	4	4	4
20	59.5	23.1	45	45	45	44	44	45	15	30	79	5	5	10
27	78.9	19.9	42	42	42	40	40	41	66	104	120	4	3	8
Dec. 4	87.2	13.2	40	40	40	36	-	36	100	100	100	7	-*	14
11	93.9	7.7	36	36	36	34	-	34	100	100	100	37	-	40
18	95.9	17.6	36	34	35	34	-	34	90	90	90	90	-	90
25	95.6	23.6	33	33	33	33	-	33	90	90	90	90	-	90
1927														
Jan. 1	95.6	27.6	33	33	33	33	-	33	90	90	90	90	-	90
8	86.8	37.2	34	34	34	34	-	33	82	82	84	47	-	43
15	68.8	50.2	33	33	33	32	-	33	73	73	74	37	-	40
22	58.6	54.7	33	33	34	33	-	33	36	34	38	34	-	36
29	63.9	55.0	32	32	33	32	32	32	21	25	28	27	33	34
Feb. 5	69.8	55.1	33	33	33	33	33	33	18	18	29	18	23	30
12	73.6	55.3	33	33	34	33	33	33	14	16	23	18	30	30
19	75.6	55.4	34	34	34	34	34	34	18	18	30	20	20	30
26	77.5	55.7	34	34	34	34	34	34	15	18	30	28	28	40
Mar. 5	79.6	55.9	34	34	34	34	34	34	12	16	20	30	30	41
12	81.3	55.7	34	34	34	34	34	34	14	20	30	32	32	40
19	92.0	53.8	35	35	35	35	35	35	17	28	35	30	30	37
26	96.3	60.2	36	36	36	36	36	36	23	34	40	32	32	31
Apr. 2	96.0	65.1	38	38	38	38	38	37	35	35	35	35	35	35
9	95.9	67.2	39	39	39	39	39	39	33	33	33	33	33	33
16	95.9	69.1	40	40	40	40	40	40	29	29	29	29	29	29
23	95.9	71.2	45	43	43	46	44	43	23	23	23	23	23	24
30	95.9	74.1	44	44	44	44	44	44	16	16	17	17	17	18
May 7	95.9	76.1	47	46	45	47	46	46	11	11	11	13	14	14
14	95.8	77.4	50	48	47	50	48	48	9	9	9	10	11	12
21	95.7	78.6	51	49	48	50	49	48	6	6	6	9	12	14
28	93.7	81.4	53	51	51	53	51	49	3	4	5	7	8	8
June 4	95.1	84.2	54	52	52	56	53	50	3	3	4	3	4	5
11	94.9	85.3	59	55	54	58	55	54	3	3	3	3	4	4
18	91.8	86.8	62	58	52	62	58	54	3	3	3	3	3	3
25	89.7	85.3	62	61	54	64	57	54	3	3	3	3	3	3
July 2	90.3	85.4	64	62	55	66	57	54	3	3	3	3	3	3

*Samples at middle not collected on account of shallow water.

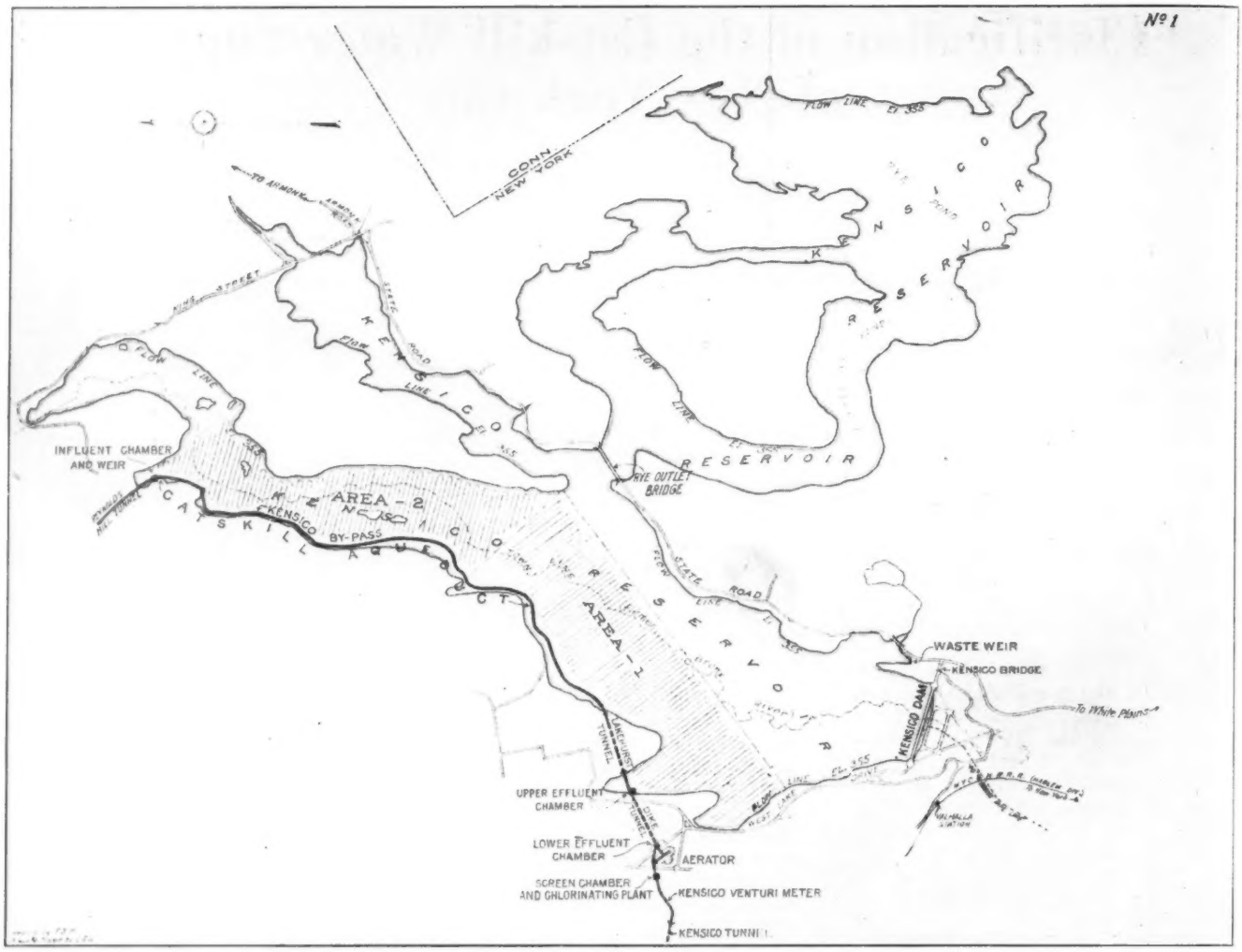


Fig. 1.—Plan of Kensico Reservoir Showing Area Through Which the Water Travels from the Influent to the Effluent Chamber

"The Manual of Water Works Practise," page 158, particles of this size would take from 2 days to about 200 days to settle 1 ft. The particles were in constant motion and this motion supports the electric theory as the reason for the long time that these particles remain in suspension.

It was evident that the water in the Ashokan reservoir in December, 1926, would not clarify by sedimentation for several months and that coagulation treatment would be necessary.

Treatment of the Water.—Laboratory tests indicated that with a grain of alum per gallon a satisfactory floc was obtained, and the turbidity reduced from 100 to about one in 24 hours. It was decided to treat with this amount of alum and to continuously feed the alum into the aqueduct at Pleasantville.* Revolving drums had been provided to aid in dissolving the alum, but it was found that without using the drums a small pile of alum formed on the bottom of the aqueduct and thereafter the amount fed in dissolved and satisfactorily mixed with the water before it reached Kensico reservoir. Daily samples were taken at the inflow point, and allowed to stand for 24 hours, and if a clear water was obtained the result was considered satisfactory. Samples were taken at varying intervals, but averaging about once a week, of the water in Kensico reservoir at a point 300 ft. from the inflow point, at 2,000 ft., at 1½ miles, and at the overflow chamber.

Results from Treatment.—The maximum turbidities recorded were as follows.

Date	Point of Sampling	Turbidity in p.p.m.
Jan. 3	Pleasantville before treatment	100
Jan. 3	300 ft. from inflow at Kensico Reservoir	60
Jan. 13	2,000 ft. from inflow at Kensico Reservoir	25
Jan. 6	7,900 ft. from inflow at Kensico Reservoir	15
Jan. 6	At efflux 13,000 ft. from inflow at Kensico Reservoir	8
Jan. 14 25 and 27	At Shaft 23, Brooklyn	7

The diagram (Fig. 2) shows graphically the changes in turbidity in the raw water and in Kensico reservoir. Early in February the turbidity had dropped to 2 p.p.m. at the effluent point, although at that time the raw water showed 55 p.p.m. at Pleasantville. In February, with a more accurate machine to record weight of alum delivered into the aqueduct, and with a turbidity below 50, the dose of alum was reduced to 0.9 of a grain and then to 0.8 of a grain. When the turbidity reached 20 the dose was reduced to 0.6 of a grain, and with a turbidity of about 10, 0.5 of a grain was sufficient. The treatment was stopped on May 28, 1927. The maximum treatment required about 44 tons of alum and 22 tons of soda ash to be fed into the aqueduct each 24 hours.

Use of Soda Ash.—The Catskill water is very soft, having a hardness of about 18 p.p.m. and has a low hydrogen ion content which is usually between 6.3 and 6.7, thus giving a slightly acid water. The addition of the alum increased the acidity, and in the early part of January the hydrogen ion content fell to 6.1, and a noticeable increase in the complaints of "dirty water" was recorded. It had been expected that soda ash, i. e., carbonate of soda, would be added when the alum was used, but none was available until Dec. 21, 1926. The water that had previously been treated was therefore lowered in its hydrogen ion content

*An alum treatment plant had been built at Pleasantville, 3 miles upstream from Kensico Reservoir, so that alum could be introduced at this point and sedimentation take place in Kensico Reservoir.

below normal, and increased the amount of iron oxide brought into solution from the piping system. When soda ash was secured it was added at the rate of about 0.5 grain per gallon, and the hydrogen ion content increased to 6.5 in February and reached 7.0 in April, (Fig. 3). The soda ash was introduced into the aqueduct at Ashokan reservoir, the proper quantity being dumped from a bag by one man at intervals of about two minutes. Tests showed that this simple method gave a thorough mixture with the water before it reached the Pleasantville plant, 75 miles away.

Record of Turbidity in Ashokan.—The turbidity of the water in Ashokan reservoir remained high throughout the winter and early spring, and it was not until the latter part of April that the turbidity in the east basin dropped below 20. The very turbid water was delivered into the east basin during December and up to the middle of January. From that time until the middle of March there was practically no inflow into this basin, but the turbidity remained high, being approximately 25 at the end of this period. Between the middle of March and the end of May there was a substantial increase in the quantity of water stored in the reservoir, the water level rising during this period some 30 ft. The final clearing up of the water in the east basin occurred during the last two weeks in May when the turbidity dropped from approximately 12 to 4. The striation of the water occurred about the middle of May and the difference in temperature between the top and bottom levels increased quite rapidly thereafter, being 4 degrees on May 23 and 8 degrees on May 31. It is uncertain as to the cause of the final rapid reduction in turbidity.

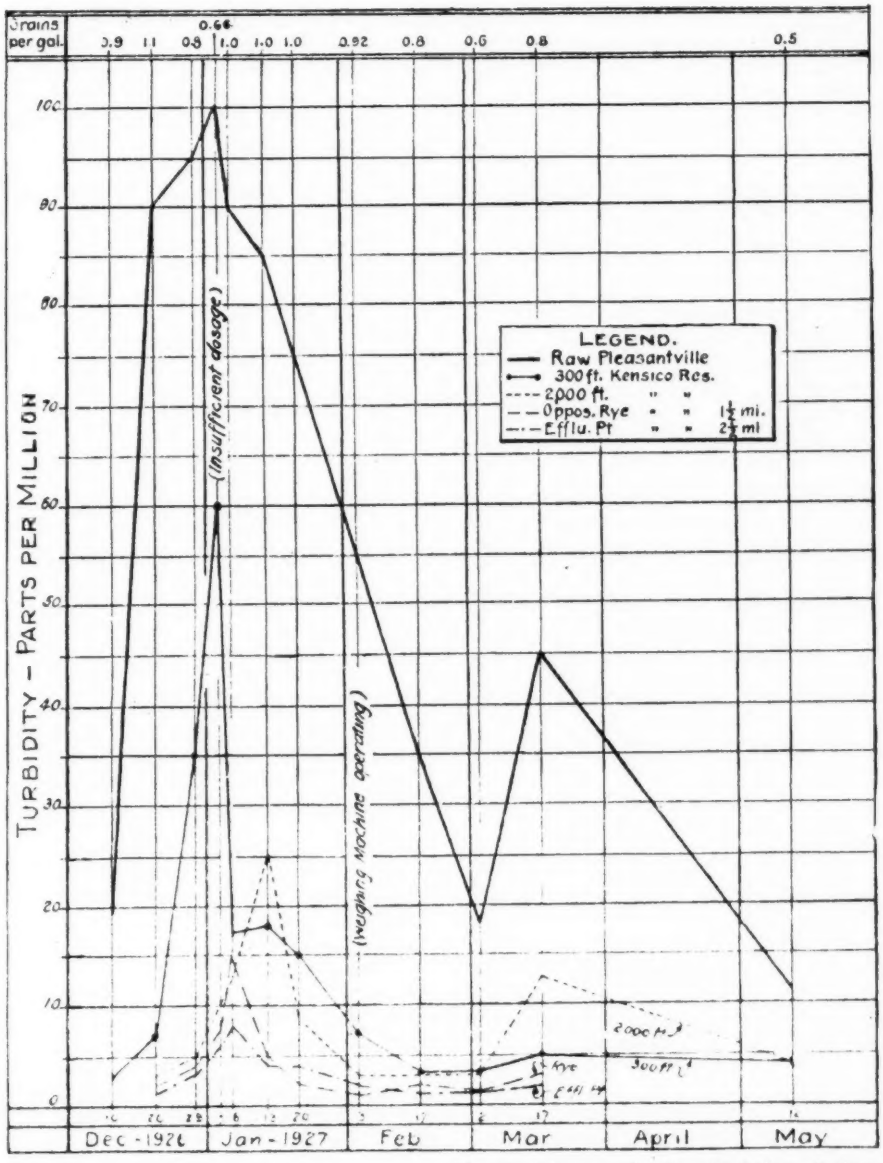


Fig. 2.—Diagram Showing Turbidity of Raw Water and Change in Turbidity of Kenisco Reservoir as the Treated Water Moved Through the Reservoir

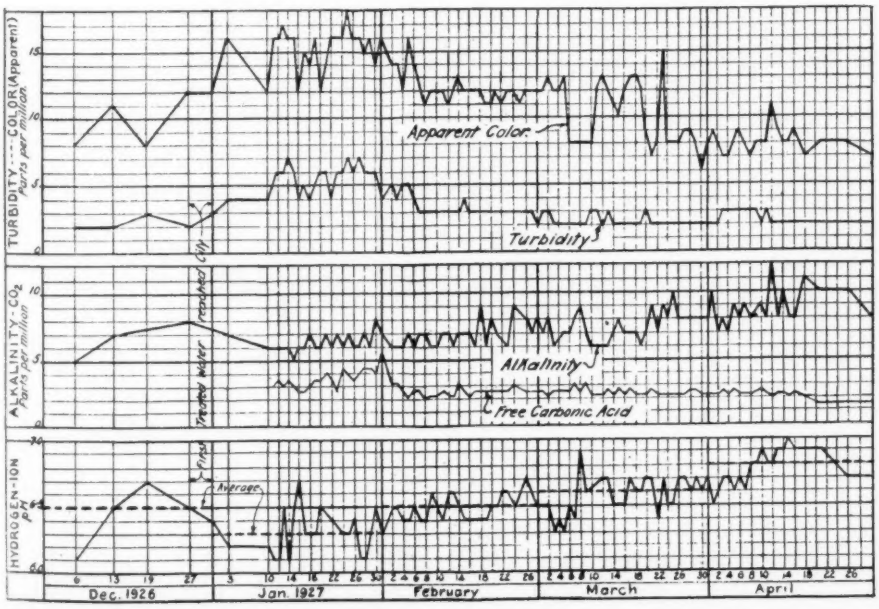


Fig. 3.—Diagram Showing Apparent Color, Turbidity, Alkalinity, Free Carbonic Acid and Hydrogen-Ion Content of Catskill Water, During Turbidity Removal Treatment. Samples Taken at Terminus of the City Tunnel, at Shaft 23, Brooklyn

A table (Table I) of the temperature of the water and the turbidity is given in detail. The following figures give average turbidity from samples taken at the surface, middle and bottom of the reservoir in each basin:

Week ending		East Basin	West Basin
December 18th		90	90
December 25th		90	90
December 31st		90	90
January 8th	Average	47	80
January 15th	Average	37	73
January 22nd	Average	37	36
January 29th	Average	32	25
February 6th	Average	24	22
February 11th	Average	23	18
February 18th	Average	23	23
February 25th	Average	32	21
March 5th	Average	34	19
March 12th	Average	23	21
March 19th		27	27
March 26th		32	36
April 2nd		35	35
April 9th		33	33
April 16th		29	29
April 30th		17	16
May 7th		14	11
May 14th	Striation occurs	11	9
May 21st		12	6
May 28th		8	4
June 4th		4	3

Condition of Alum Floc in Kensico Reservoir.—Some question has been raised as to the condition of the alum after it settled with the clay to the bottom of the Kensico reservoir. The possibility of this material coming again into suspension in the water would be very disturbing if there was any indication of such action in the future. To date there has been no evidence that the alum and clay will not permanently stay on the bottom. When it has been stirred up it quickly settles again, and it would seem very unlikely that the overturning of the water due to temperature changes would move this material. It is, however, too soon to make a positive statement on this subject.

Cost of Treatment.—The alum treatment was commenced on Dec. 9, 1926, and stopped on May 28, 1927. The soda ash treatment was started on Dec. 21, 1926, and ceased on June 3, 1927. The cost for alum treatment was:

4,635 tons alum	$145,290	
Hauling alum from railroad siding to plant	6,773	
Labor for handling alum at plant	5,640	
		$157,703
Credit from sale of alum bags		1,775
Net cost of alum treatment		$155,928

The cost for soda ash treatment was:

2,671 tons soda ash	$77,387	
Handling the soda ash, including unloading, hauling, storing and delivery into the aqueduct	7,900	
		$85,287
Credit from sale of empty bags		1,500
Net Cost		$84,787

During the period that the Catskill water was treated the consumption of water from the Catskill system was 93,243 m.g. The resultant cost per m.g. treated was in round figures $2.60. There are approximately 4,000,000 people who receive their water supply from the Catskill system, and the cost per person amounted to about 6 ct. for nearly six months' treatment.

Meeting of Kentucky-Tennessee Section of American Water Works Association

The third annual meeting of the Kentucky-Tennessee Section of the American Water Works Association convened at the Kentucky Hotel, Louisville, Ky., at 11:00 a. m. on Jan. 19th, 1928, with W. S. Patton presiding.

The Honorable William H. Harrison, Mayor of Louisville, extended greetings on behalf of the city. Col. F. W. Albert responded.

"Water Supply and the Public Health" was the subject of an address by Dr. P. E. Blackerby, Assistant Secretary of the State Board of Health of Kentucky.

After appointment of committees, the meeting adjourned until 2:00 p. m.

"Service and Public Relations" was given by W. C. Stair, Middlesboro, Kentucky, and was discussed by J. E. Davis, W. S. Cramer, F. W. Albert, S. L. Allen, C. A. Orr and James Sheahan.

"Water Works Supervision and Cooperation with the Water Works Department" by A. E. Clark, Nashville, Tennessee, was discussed by F. C. Dugan, J. H. Swope, W. S. Cramer, and W. S. Patton.

"The Use of Uranine Dye in Tracing Underground Waters" by A. W. Crouch, McMinnville, Tennessee, was discussed by F. C. Dugan, James Sheahan, and F. W. Albert.

Major J. H. Howland of the National Board of Fire Underwriters spoke on "The Standardization of Fire Hose Threads." A general discussion took place and the Resolutions Committee was instructed to prepare a statement for action by the section.

The Nominating Committee reported that the new Executive Committee would consist of Col. F. W. Albert, Knoxville, Tenn., Chairman; W. H. Lovejoy, Louisville, Ky., Vice Chairman; C. A. Orr, Mayfield, Ky., Director, and A. E. Clark, Nashville, Tenn., Director. The Executive Committee re-elected F. C. Dugan, Louisville, Ky., Secretary-Treasurer.

A get-together dinner was held at 6:30 p. m., after which motion pictures were shown by The American Rolling Mill Co.

The section reconvened at 9:00 a. m., January 20th.

Major J. H. Howland read a paper entitled "Requirements for Fire Protection and Methods to Determine Quantity Available." It was discussed by J. L. Thompson, F. W. Albert, A. Clements, and W. S. Cramer.

"The Design of a Distribution System" by A. P. Learned, Kansas City, Mo., was taken up and discussed by F. W. Albert.

"The Development of the Distribution System of the Louisville Water Company," by L. S. Vance, Louisville, Ky., was read and discussed.

The afternoon session was devoted entirely to "Management of Water Works." Mr. W. S. Cramer, Lexington, Ky., discussed "The Management of a Privately Owned Water Works." Col. F. W. Albert presented a paper on "The Management of a Municipally Owned Water Works," and W. S. Patton, Ashland, Ky., a paper on "Some Problems in Management." The papers brought forth considerable discussion.

The Vogt Brothers Manufacturing Co. entertained the members with a supper at their plant.

The morning of Jan. 21st was devoted to papers on water treatment.

"The Water Supply Situation in Kentucky" was given by E. E. Jacobson, Louisville, Ky.

"The Progress of Water Supply Purification in Tennessee" was given by H. R. Fullerton, Nashville, Tenn.

"The Design and Construction of Small Filtration Plants" was given by H. K. Bell, Lexington, Ky., and was discussed by C. N. Harrub.

"The Trials of a Small Filtration Plant Operator" was discussed by W. H. Johnson, Harrodsburg, Ky., and D. J. Niemeier, Shelbyville, Ky.

"Algae Control by Artificial Turbidity," by W. H. Lovejoy, Louisville, showed what was being done by the Louisville Water Company on this subject.

The Committee on Resolutions reported and their report was accepted.

An inspection trip to see the methods used in cleaning underground pipes and the filtration plant of the Louisville Water Company took up the afternoon session.

Announcement was made that the 1929 meeting would be held in January at Knoxville, Tenn.

Refuse Collection at Toronto, Ont.

The general activities performed by the Department of Street Cleaning of Toronto, in addition to the cleaning of public thoroughfares, the oiling of unimproved roadways, snow removal and cleaning catchbasins, also includes the collection and disposal of household waste material. Some interesting information on this latter activity was given by Geo. W. Dies, Street Commissioner, in a paper presented at the recent conference of the International Association of Street Sanitation officials.

The collection of refuse is the most important from an expenditure and public service viewpoint. During 1927 $1,100,000 was expended upon the collection of ashes and garbage, while the total tonnage of refuse collected, amounted to 264,361 tons of ashes and 138,654 tons of garbage.

Number of buildings collected from	117,403
Collection calls per annum	11,740,300
Total cost per collection per bldg.	$0.09
Cost per building per year	9.45
Cost per ton for collection	2.74
Average tonnage of ashes and garbage collected from each building per year	3.4
Cost per capita	$1.90

In 1915, Toronto adopted the policy of incineration for the disposal of garbage and combustible material. Since that date three destructors have been constructed, and 88 per cent of the garbage collected, or 125,000 tons, are destroyed annually by incineration.

The Don Destructor was placed in operation in July, 1917, at a cost of $225,000, exclusive of land. The plant consists of three high-temperature four-cell "Sterling" furnace units, and during the last year destroyed 52,000 tons of garbage at an actual cost of 1.5 man hours of labor per ton.

The Wellington Destructor was placed in operation in January, 1925, at a cost of $550,000, exclusive of land. The plant consists of four high-temperature four-cell "Sterling" furnace units and during last year destroyed 70,000 tons of garbage at an actual cost of 1.3 man hours of labor per ton.

Method of Constructing Surface Treated Roads In Hillsborough County, Fla.

Construction Features of Recently Completed 89-Mile Highway

By P. F. ROSSELL

TO Northern engineers, some aspects of the location and construction of roads by Hillsborough County are unique. It may, therefore, be of interest to describe a project just completed.

Location of Work.—This project, located in the 5th Commissioners District, which comprises about one-third of the entire county, included 89 miles of highway as follows: Brick with asphalt filler 36,709 sq. yd.; shell base with sand covered surface treatment 51,649 sq. yd.; Florida lime rock base with slag covered surface treatment 715,838 sq. yd.

Structures.—Concrete culvers were of the standard box type offering nothing unusual in design or construction. Several locations were encountered requiring special study due to existence of muck. In practically all such cases the depth of muck was determined and piles jetted to secure proper bearing. In some cases where the muck was not deep, it was removed and the culvert carried down so as to bear directly on suitable material, usually sand or hard pan.

All bridges were of standard timber construction, 20 ft. clear roadway, four pile bent, 15 ft. centers, 4 x 12 stringers, ten to the span. In all cases piling was jetted and bearing was secured either on stiff clay or rock. Due to the lack of high water during construction, this work progressed in a rapid and economical manner. This item was not included in the general contract but was executed under direction of the writer with local labor. For this work an appropriation of $67,000 was allowed. Cypress timber and piling were shipped to a central point and creosoted by us by dipping. This gave fair results. The bridge crew consisted of one superintendent, one foreman and nine men. Speed was obtained by the men camping at the various bridge sites. In addition to the usual small tools, the following comprised the complete outfit used by this gang: One Ford truck and trailer, one A-frame, one Fordson tractor and one 3-hp. Fairbanks-Morse engine and pump, 2 in. feed and ¾ in. jet.

Surveys.—The contract was let before any preliminary studies were made and surveys and construction began practically at the same time. Even with this handicap no serious obstacles or delays were met. Practically all of the location followed land lines and this facilitated and speeded up the work.

Section of Asphalt-Filled Brick Highway

Our right of way is 60 ft. with fences set back 32 ft. from the center line. This was increased at certain places where it was necessary to widen out in order to secure the required amount of material for fills. In these cases, a berm of about 10 ft. was left intact outside the toe of slope. In these cases we were fortunate in securing a good sandy material for the fills.

Excavation.—As a general rule our excavation is rather light but some of our fills at river crossings were heavy. In some cases change in river channel necessitated considerable excavation. Heavy fills were thrown up at the beginning of the job, thus getting advantage of the rainy season. It is necessary to exercise great care to remove all clay from the subgrade.

We have had cases where, notwithstanding conscientious foremen and inspectors, clay balls have worked from the subgrade completely through the rock base within 24 hours. Due to honest cooperation of the contractors these defects were detected and promptly corrected. In this connection I might say that I have seen clay being removed from the surface of roads in Florida, which roads have been under traffic for upwards of two years before the clay worked to the surface. The total yardage moved by the contractor in grading for the highway amounted to 630,000 cu. yd.

Drainage.—Due to the flat nature of the country traversed, quite an elaborate system of lateral ditches was necessary to insure protection during the rainy season and to aid in lowering the ground water level. A great many of these ditches were dug with the county's dragline by our own forces.

Construction of Lime Rock Base.—Stakes were set to line and grade 11.5 ft. off center, as this distance proved most convenient for the contractor. Form boards 2 in. x 8 in. were set 7.5 ft. from center line to inside of board, so as to insure our full 15 ft. of road. After the form boards had been set, the subgrade was watered thoroughly and where possible, rolled, then checked by means of a templet. The base for the brick road and the sand covered surface treated ones were of shell and the same treatment of subgrade and material was followed as with Florida lime rock base. The most interesting and unique feature to a Northern engineer is the lime rock base, sometimes called Ocala lime rock, due to the fact that numerous quarries are operated near the town of that name in Marion County, where this rock was first mined in 1884. This material is almost pure limestone, so much so, in fact that our specifications require the contents to be 97 per cent pure lime. It is furthermore required that it shall be free of clay, sand and other impurities. Inspection of each car is most rigid and none can be unloaded until thoroughly inspected. Although these requirements appear to be and in fact are rigid, out of the entire quantity received on this project, only 20 cars were condemned.

It is rather a simple matter to tell when a shipment meets the specifications due, no doubt to the fact that when the rock is dirty, this is caused by clay pockets in the quarry being

Section of Highway Which Received 2-Course Surface Treatment

blown down and mixed with the pure rock. Usually when this happens, it is in such quantities that it is easily detected. When working in a face free of such pockets almost pure limerock is produced.

The rock is hauled from the railroad siding in dump cars and deposited upon the subgrade. In no case are the trucks permitted to pass beyond the rock already spread. Great care must be exercised to keep the rock clean and to so dump, spread and work it that no sand will become incorporated with it. Sand is usually mixed with the rock during construction, either by the loaded truck rocking back and forth in dumping, causing the sand to squeeze up adjacent to the wheel or by the trucks running outside the form boards and whipping sand onto the rock base.

Care must be taken that all sand pockets are dug out and this material thrown outside the forms before scarifying and blading are done.

The rock was spread either with forks or round pointed shovels, sometimes supplemented with a Russell grader. The combination of shovels and grader gave the best results. Considerable experience is required to properly work Florida lime rock and even the famous "20" year men will make glaring errors unless properly supervised.

After the rock is properly spread, water is added to it while still open and until it is thoroughly wetted, then it is rolled, scarified and bladed and this operation repeated until the base conforms to the proper section. Unless this work is properly executed, defects such as laminations and wavy edges will result.

When edges must be brought up or laminations removed, it is better to rescarify the entire width of road to a depth of 3½ to 4 in., adding water and fresh rock. When the base receives a final blading, this bladed material should be whipped off the rock base completely; if this is not done, more laminations will result.

Thorough consolidation is secured by rolling with a 3-wheel roller weighing at least 300 lb. per inch of width of wheel.

Some engineers appear to desire a definite quantity of water to be applied to the rock. It has been the writer's experience that this is a question which can be decided only by judging local conditions and the application of sound judgment based upon actual knowledge of just how the rock will act under the conditions encountered. Under some conditions on this job no water was applied to the subgrade and none to the rock, yet the base rutted under traffic and as much as four days continual blading were required before the desired surface could be obtained.

Factors to be taken into consideration are the moisture content of the soil and rock and the weather condition. The rock being of very fine texture invites capillary attraction, especially under traffic. From the above it is seen that no hard and fast rule can be laid down governing the quantity of water to be applied. Frequently sand known locally as ball bearing sand is encountered which holds as much water as a sieve and under such conditions we usually keep the pump going day and night and even then are not satisfied with the compaction of the subgrade secured.

Usually one day's run is worked up and finished on the following day so as to assure the presence of the proper amount of water for cementation. Immediately thereafter the thickness is tested. The average rock base laid by one outfit in one day was 2,000 sq. yd., with a maximum of 3,333 sq. yd.

Prime Coat.—After the base had properly cured and "set-up," which period is dependent upon water content, weather conditions and traffic and meets the specifications in all respects, it was accepted for application of the prime coat. All loose material and foreign matter was carefully removed and Tarvia "B" applied at a rate dependent upon the tightness of the base. Our specifications called for 2/10 gal. per square yard but this quantity was applied only when the base was dry and able to absorb it. During wet weather it was found that the base would not properly take up more than 15/100 gal. per square yard and this quantity was applied with good results. For the shell base we found that two applications of 2/10 gal. each were required. When possible, traffic was blocked until the prime had thoroughly penetrated the base. Where excess spots occurred and when not possible to block traffic, the prime, after say 24 hours, was covered with clean sand to blot the excess and avoid pickups. After a period of seasoning, which varied from a week to ten days, the road was again swept clean of all foreign material and Texaco macadam binder was applied at the rate of 4/10 gal. per square yard at a temperature of 275 degrees F. This is followed immediately by a covering of crushed slag at the rate of 35 lb. per square yard and rolled with a tadem roller. The top or asphalt was applied during a period of heavy and frequent showers and while we never permitted its application on a wet base, often times immediately after it was laid, heavy chilling rains fell before the slag was applied. The finished job in such places showed a uniform and perfect mat as does the entire job, speaking well for the material and workmanship.

Construction of Brick and Sand Covered Surface Treated Roads.—The brick road was constructed on 4 in. shell base with sand cushion and Texaco No. 39 paving filler. The sand covered surface treated roads were constructed of 6 in. compacted shell. Tarvia "B" applied as noted elsewhere as a priming material and Texaco macadam binder applied at the rate of 4/10 gal. per square yard for the top or seal coat and then covered with triple washed concrete sand.

Bermuda grass was planted on some of the shoulders and as soon as the rains start, this will be continued until the entire mileage has been planted. Due to the sandy nature of the soil, it is a point of economy to grass the berms and slopes as otherwise the cost of maintenance would be excessive.

Unit Prices.—The unit prices bid on this job were:

Clearing and grubbing, per acre	$55.00
Excavation, per cu. yd.	.25
Class "A" concrete, per cu. yd.	28.00
Two course surface treatment, per sq. yd.	.28
6 in. Florida lime rock base, per sq. yd.	.90
18 in. concrete pipe, per foot	2.85
24 in. concrete pipe, per foot	3.65
Re-inforcing steel, per lb.	.06
Shell base, cu. yd.	2.20
4 in. x 12 in. concrete curb, per foot	.45
Old brick laid, per sq. yd.	.50
New brick laid, per sq. yd.	2.50

The general contractor was Smith Brothers Construction Co. of Dallas, Tex., and Tampa, Fla., with T. D. McGinnis as manager and Wm. Taylor, superintendent. W. T. Williams is chairman of the Board of Commissioners for Hillsborough County and Commissioner from the 5th District. A. B. Pimm, County Engineer and the writer, chief engineer on the project.

The Epochal Disintegration of Electrons in the A. T. & T. Laboratory

By HALBERT P. GILLETTE
Editor

WHAT has been termed an epoch making experiment in the realm of physics was made public Dec. 30, 1927. It was the breaking up of electrons into their constituent elements by Dr. C. J. Davisson of the research staff of the American Telephone and Telegraph Co. (the Bell system). This achievement was described in a paper presented to the American Physical Society.

For about a century all atoms were thought to be "ultimate particles" of matter. In 1815 Prout advanced the theory that all atoms are built up of the "elemental atom" hydrogen. This theory has only recently become firmly established, with some modifications of Prout's original conception.

Although there were prior surmises that hydrogen and other atoms are composed of discrete particles ("corpuscles," as Thomson called them, and "electrons," as they later came to be called), it was not until about 30 years ago that the electron theory of matter may be said to have become firmly established. The electron (or negative electric charge) was thought by many to be the "ultimate particle." There is also a positive nucleus in each atom, which was long regarded as probably being another kind of "ultimate particle" until it was found possible to knock electrons out of it; since this was done, considerable mystery has enveloped the "positive electron."

So far as I know the electron was universally regarded as the ultimate unit of matter (with perhaps another sort of ultimate unit in the positive nucleus), until the theory that the electron is contractile or elastic came into vogue, and was completely established, independently by Lorentz and Einstein. It then must have occurred to others, as it did to me, that an electron to be elastic is probably composed of discrete particles that are brought closer together under pressure. Assuming this to be so, and adopting the hypothesis that the escape of these constituent particles (which I called etherites) from electrons not only accounts for the various forms of radiant energy but for gravitation and motion of masses, I was able to deduce the three basic relativity formulas of Einstein in an exceedingly simple manner (See Engineering and Contracting, August, 1927).

There is very strong probability of the truth of any theory by means of which any quantitative law of nature can be deduced. The probability of its truth increases more rapidly than the number of laws thus deduced. Nevertheless it is always desirable to establish the premises of a theory by experiment, and this has now been accomplished for one of the premises of the etherite theory by Davisson's success in disintegrating electrons. Another of the premises of the etherite theory finds experimental verification in the fact that assymetrical radiations have been produced in the laboratory by the impact of beta rays, as stated in my article above mentioned. None of the premises of the etherite theory now lacks experimental confirmation, except the premise that the radiated etherites escape with the velocity of light.

The positive charge of the nucleus of the hydrogen atom remains a mystery. Although negatively charged electrons have been isolated, no positively charged electron has ever been similarly isolated. When electrons are driven out of a nucleus they are always negative. The nucleus of the hydrogen atom weighs about 1,800 times as much as an electron, and it seems not unlikely that it is composed of about 1,800 electrons, all but one of which is neutral, that one being positively electrified. If so, it may be that it is the direction of axial rotation of an electron that determines whether it attracts or repels another electron.

This hypothesis seems to require some general force that orients free electrons. Possibly this is to be found in the resistance of the ether through which our solar system is traveling at the rate of about 130 miles a second.

If Davisson can now completely smash the proton, or positively charged nucleus, into electrons, it will be quite probable that it is the direction of axial rotation that determines the differences in attractive and repulsive nature of the ultimate unit-charges, the electrons.

An Early Conception of the Water Cement Ratio Relation

We are indebted to R. S. Swinton of the Department of Civil Engineering of the University of Michigan, for the following interesting letter that appeared in the Niles Register in 1817. The letter was discovered by W. J. Worth, one of the students in the course on the History of Engineering, which Mr. Swinton has been teaching this term:

EXCELLENT CEMENT
(Niles Register, 1817)

Experiments shewing the progress made in discovering the materials for a water cement, among our domestic resources, in a letter to Dr. Mitchill from David Meade Randolph, esq., of Virginia, dated Richmond, 26th June, 1817.

Dear Sir: Among the great variety of useful inventions connected with the arts, as it has been lately my object to pursue and to have observed in England, it was one of great importance to my mind, to discover in this country something that might answer an equally valuable purpose with the famous "Dutch Terias," or Parker's "Roman Cement," as it is now generally used in England and the West Indies for works under water and elsewhere situated.

In this pursuit it has been my good fortune to succeed so far as to indulge a confidence that upon the more satisfactory test of works upon a large scale, and a reasonable term of time for experience, there can be nothing discovered of more importance to the construction of durable foundations either under fresh waters or those of the sea, than those certain minerals that I take the liberty of transmitting to you herewith. These will be found in two stone pots to your address. One of them contains a powder which I conceive to possess the properties of Puzzolana, or the cellular basalt of Dr. Rees; the other is a lime produced from certain concretions of lime, clay and other matters found on the banks of the York river, near to the town of Little York. These jagged and various irregular sized (apparently) rocks seem to have been formed a little below the adjacent land, and to have tumbled from them as the washings of the tides have worn them down; for many fragments or distinct masses are seen pendant from their beds. The quantity is very extensive, and, from some parts of the same banks, the vertebra and other bones of some huge land or sea animal are found to have been dislodged likewise. This lime rock, upon being calcined, falls to an impalable powder. It does not slack like other limes; on the contrary by the application of water as in slacking other limes, the powder forms itself into a mass, and coagulates by lying; and when made into a paste, forming a plate of it, suspecting it to dry, it assumes a stony or hard appearance, which being immersed in water before it is quite dry, too, it does not dissolve like paste made of other lime.

One of those pots aforesaid (the other) contains a mixture of this lime powder and the powdered basalt, in the proportion of lime two, basalt three, which from my experiments seems to be the most perfect for terias mortar. They are to be reduced to a plastic state, by adding the smallest quantity of water possible, and that by little and little, to aid the beating in rendering it tough. Observe this rule—the more beating and the less water, the firmer the mortar. Hence you will perceive, sir, that my researches have been to the best chemical authorities, as far as my simple capacity has enabled me to understand from Dr. Rees and some others upon this subject. My acquirements and ability to investigate and to understand, are solely from exercising my practical knowledge and limited powers of mind; whilst I would most respectfully solicit your enlightened aid to mature my purpose, and to stamp a character upon my inventions.

Two bricks were cemented on the 1st of this month with a mortar far less perfect than the above and instantly (while the mortar was soft) they were placed in a basin of water, where they have remained ever since. The cement grows harder with time, and is very preceptible; and from the crust that is evidently forming on the surface, I am expecting a crop of Stalactites.

You will readily perceive, sir, that if the invention shall prove effectual, I am fairly entitled to a reasonable compensation, to be secured by a patent or otherwise, and that your kind assistance in the promotion of my object would be gratifying in an eminent degree. In conclusion, sir, I pray you would have the goodness to favor me with a reply; for my apprehensions of having trespassed too far on your benignity can only be relieved by your favorable reception of this appeal to your liberality, and by such orders for a supply of the crude materials as you shall be pleased to give your most respectful and humble servant.

D. M. RANDOLPH.

Rock Asphalt Top on Concrete Base Paving on Louisville Boulevard

Utility Mains Placed in Grass Plots Paralleling Paved Area

By W. J. HORRIGAN

W. J. Horrigan & Associates, Inc., Consulting Engineers, Louisville, Ky., and Engineers for Board of Park Commissioners, of Louisville

THIS boulevard, known as Western Parkway, is the principal and only direct route in the western section of the city connecting North and South Louisville. It is also important from the fact that it connects two of Louisville's most beautiful parks—Shawnee and Iroquois. It is about 5 miles in length, and, in general, passes through undeveloped territory. However, a portion of the territory is being developed as an industrial section and among the important industries is that of the Ford Motor Car Co., which has one of the largest plants in the south located on the parkway.

The parks and parkways of the city are under control of the board of park commissioners, consisting of six members appointed by the mayor, and under existing regulations the type of traffic permitted on parkways is limited to light delivery trucks, with pneumatic tires. Inasmuch as the greater portion of the territory adjoining the parkway is ideal for industrial plants, the board of park commissioners is compelled to construct a type of pavement capable of carrying heavy traffic, in order that the type and amount of traffic will not have to be restricted.

General Features.—The width of the parkway is 120 ft. between building lines, and the improvement was designed so that the roadway, including curb and gutter, is about 37 ft. wide, leaving 83 ft. (or 41½ ft. on each side) for grass plots and tree planting. With this in mind, plans and specifications were prepared for a roadway surface 33 ft. in width, with combination concrete curb and gutter, the curbs being 6 in. in width and the gutters 18 in. in width. Bids were received on four types of surface, as follows: Reinforced concrete, Illinois type; sheet asphalt; asphaltic concrete on concrete base; and rock asphalt on concrete base.

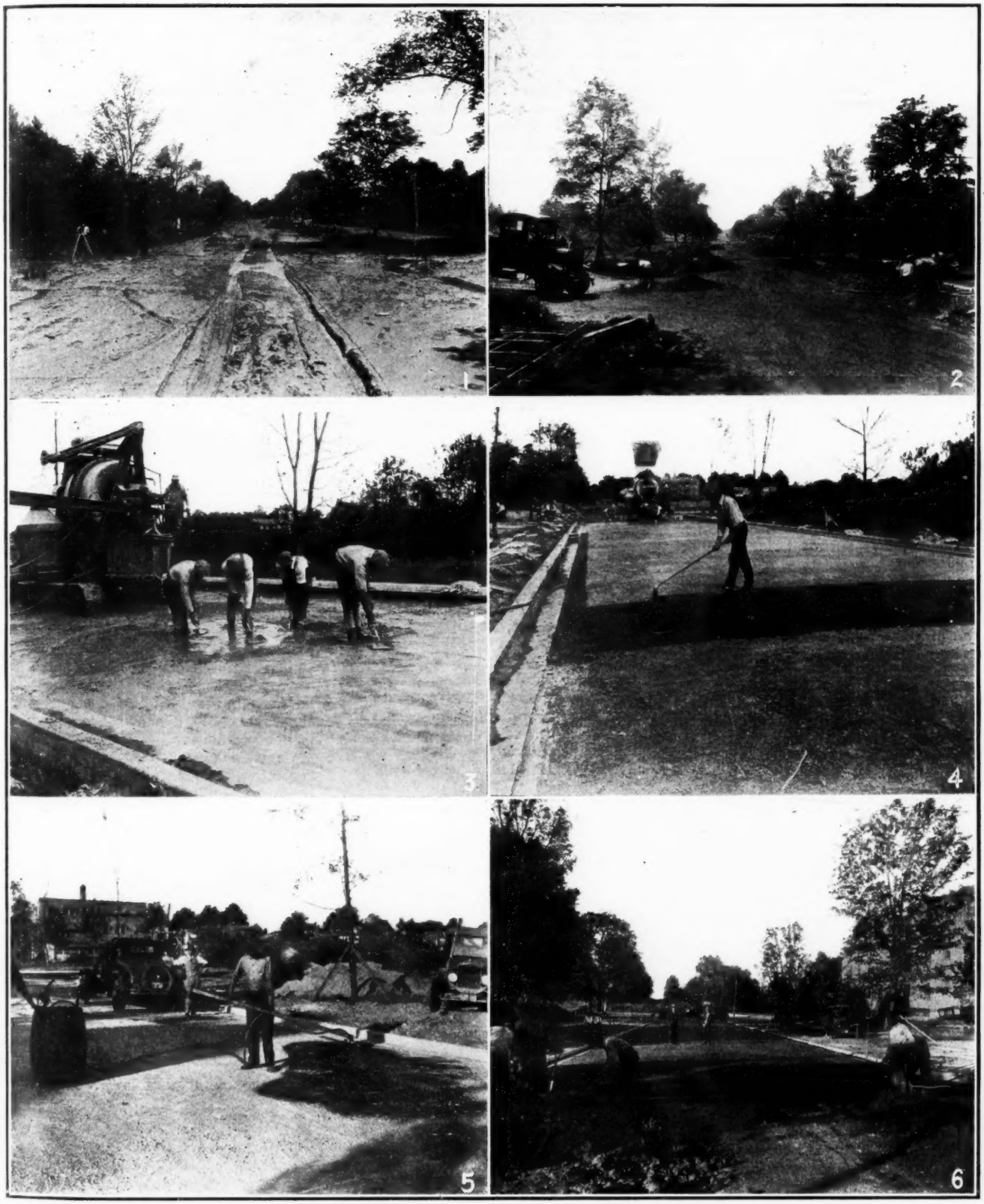
The board of park commissioners after careful consideration, selected the rock asphalt surface.

Construction Details.—The curbs and gutters are of the combined type and constructed of plain 1:2:4 Portland cement concrete.

The roadway paving consists of a 6-in. 1:3:6 gravel concrete base with a 1½-in. compacted Kyrock wearing surface. The concrete was mixed for the base by a Smith paver and after being spread and finished to the proper thickness and contour, was smoothed in such a manner that no point varies more than ¼ in. from the true contour. The base was finished smooth in order to secure the maximum carrying capacity of the full thickness of the base. Before obtaining its initial set the surface was slightly roughened by means of a rattan broom, operated transversely, so that the corrugations are at right angles to traffic. It was then allowed to cure for about three weeks. Immediately prior to laying the Kyrock the surface was painted with an application of "cut-back" asphalt, for the purpose of securing a clean surface and bond with the base.

The Paint Coat.—Considerable discussion took place as to the value of a paint coat. Some experiments were made and it was discovered that the use of paint coat enables the Kyrock surface, which is somewhat friable, to grip the concrete surface in a manner not obtained when the material was

View of Western Parkway, Louisville, Ky., Showing the Completed Pavement Construction Features of Paving Western Parkway, Louisville.



Construction Features of Paving Western Parkway, Louisville, Ky., with Rock Asphalt Top on Concrete Base

(1) Condition of Sub-Grade Over Which the Boulevard Had to Be Built. Considerable Filling Was Necessary in Places. (2) Excavating for Combination Curb and Gutter. (3) The 6-in. Base of 1:3:6 Gravel Concrete Was Finished to Full Depth, Tamped with Shovels and Finished Smooth on Top so That No Point Varied More than ¼ in. from the True Contour. (4) Before the Concrete Base Had Obtained Its Initial Set, the Surface Was Slightly Roughened by Means of a Rattan Broom Operated Transversely So That the Corrugations Would Be at Right Angles to Traffic and Thus Afford Better Anchor for the Kyrock top. (5) Immediately Prior to Laying the Wearing Surface, the Roughened Concrete Base Was Painted with a Light Spray of Cut-Back Asphalt to Cement the Dust and Loose Particles Resulting from the Roughening Process, in Order to Insure a Perfect Bonding of the Rock Asphalt with the Base. (6) The Rock Asphalt Was Dumped on the Painted Base Directly Behind the Shovelers. Sheet Metal Guides Were Used to Enable the Rakers to Secure Uniform Thickness in Spreading. The Guides Were Pulled Forward on the Base as the Work Progressed. The Section in the Background Has Received the First Rolling.

placed on a non-painted base. The rock asphalt was spread in the usual manner, with the exception that sheet-metal guide strips were placed at the center and quarter points to secure uniformity in spreading. After raking to grade, the Kyrock was permitted to remain without being rolled until the following day. It was then rolled with a tandem roller.

No Utility Mains in Paved Area.—One interesting and important feature of the roadway is the fact that the pavement area is free from utility mains, such as sewer, water, and gas below the surface. All such utilities are placed in the grass plots adjoining the roadway area. In addition to eliminating a possible base failure over the trenches, regardless of how well back filled, it prevents the pavement from being opened at any time to insert house connections or repairs to mains. The fact that very few residences and other structures now exist, the practice of placing the utility mains in the roadway and extending house connections to the curb line was not possible. Experience of over 20 years has taught us that connections inserted a considerable length of time before property is developed are rarely in the proper place for the building. Inasmuch as considerable building is expected on this parkway during the next three years, this pavement would be a mass of repaired openings rather than a smooth finished and pleasing surface.

The contractors for this project were: J. U. Schickli & Bro., Inc., who performed the excavation, curb and gutter, concrete base, drainage, etc.; R. B. Tyler Co., W. N. Bosler, chief engineer, laid the Kyrock wearing surface. W. J. Horrigan and Associates, engineers, were represented by W. W. Pardon and N. R. Guthrie, Jr., resident engineers.

New Method of Dam Construction

A new dam to be built at Marege, in the Haute-Dordogue, France, will involve a novel method of construction, according to the Times Engineering Supplement, London. The conventional form of dam consists of a single wall, either straight or curved, which by its mass and thickness is enabled to hold up a certain weight of water. This method of construction, however, is costly and requires large quantities of material. If, however, a series of walls, each comparatively thin, can be substituted for the single mass, a saving in labor and material can be obtained; moreover, some of the water itself can be made to act as a counterweight and the quantity of masonry required can be still further reduced.

A design on this principle has been adopted for the Marege dam. Instead of a single wall, five thin curved shells of reinforced concrete are to be placed one behind the other; each will be somewhat lower than the last, so that the desired head of water will be obtained in five stages instead of in a single step. When the system is filled with water, the water in each compartment will rise to the top of the lower wall and will help to support the higher wall up to that height; only one-fifth of each wall, and that at the top of it, where the pressure is least, will be subjected to pressure acting in one direction only. The first four walls will not need to be thickened at their bases, and an economy of over 25 per cent will be effected.

Tests have been made on a scale model in the following way: The density of mercury is 13.6 times that of water; if, therefore, a model of the dam is made of the same materials as the dam itself but on a scale of 1 to 13.6, and filled with mercury, the resulting pressures are equivalent to those which would be obtained in practice. The scale, however, is still impossibly large; but this difficulty can be overcome by altering the material. A certain kind of plaster is consistently 7.35 times less resistant than concrete; when this plaster is used instead of concrete, and mercury instead of water a multiplication of forces of 7.35 times 13.6, or 99.96, is obtained. A model on a scale of 1 to 100 made of this material will, therefore, give all the results that are wanted. Such a model has been constructed, and by emptying one or more of the compartments the walls have been tested with varying loads.

Trencher Attachment Now Supplied for Bay City Tractor Shovel

The Bay City Tractor Shovel is now available with a trencher attachment suitable for general trench excavation, according to a recent announcement coming from the Bay City Dredge Works, of Bay City, Mich.

The trench or ditcher attachment for the Bay City Tractor Shovel is so designed that it can be installed on any Bay City Tractor Shovel. The attachment consists of an extension mast, boom and trencher bucket, patterned almost exactly after the ditcher attachment furnished on the Bay City Model 16-B ¾-yd. convertible excavator, which is already known to contractors. This attachment will dig to a depth of not more than 11 or 12 ft. and is designed for trench or sewer excavation, pipe line excavation, the excavation of house sewer connections or the excavation of basements on jobs, where it is desired to keep the machine on top of the bank.

The machine has three propelling speeds, the fastest of which is 3½ miles an hour. It is one-man operated and equipped with full-crawler mounting. The bearing pressure per square inch of ground surface is only 5½ lbs. Power is supplied by the McCormick-Deering tractor. The machine is designed with very fast operating speeds and special analysis steel, Timken roller bearings, etc., are used throughout.

The standard bucket width is 24 in. Slightly narrower or wider buckets can be furnished. The bucket dumps by inverting.

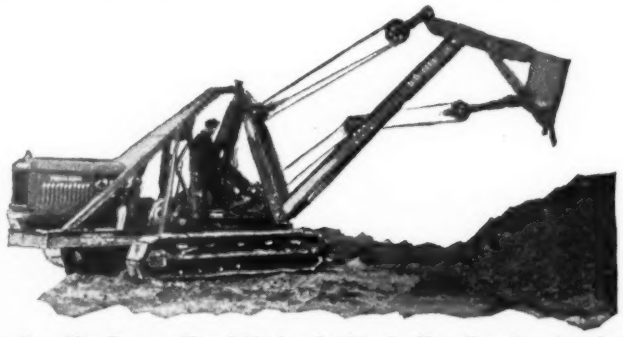
Cook County, Ill., May Light Roads

The highways in Cook County, Illinois, in which is located the city of Chicago, may soon be illuminated by a vast lighting system if a survey to be prepared by leading engineers for the county board shows that the cost is not prohibitive.

Commissioner Frank J. Wilson, in a resolution referred to the roads and bridges committee of the board, recommends that the 500 miles of highway be lighted as a preventive against crime and as an aid to safe driving.

"We have the greatest system of paved highways in the world," Commissioner Wilson said, "but our network of roads not only is of service to motorists, but also affords avenues of escape for criminals. In their present unlighted condition, the roads make night driving hazardous.

"Other counties in the country have given considerable attention to the proper lighting of their roads, and it is now time that Cook county gave some thought to the matter."



The Bay City Tractor Shovel Equipped with the New Trencher Attachment

Two Problems in City Paving

Extract from Paper Presented at 14th Annual Purdue Road School

By W. W. HORNER
Chief Engineer, Sewers and Streets, St. Louis, Mo.

In two respects, the city paving departments fail to measure up to the full expectation of the citizenship. The first of these is in the matter of surface smoothness and ease of riding on our newer streets. Most of us feel that we are doing a pretty fair job in this respect, but our country cousins, with all the advantages of highly organized mechanical equipment, are doing better, so that our city automobile owners returning from a pleasure drive outside, are filled with a mild discontent at the small jigging their wheels receive over some apparently smooth asphalt. However, little criticism may be justified, the demand for further smoothness is here, and it will be up to us to set aside our self-satisfaction with our present work and find means of further improvement. I have mentioned the disadvantage at which we are working on account of the absence of high grade mechanical equipment for the finishing of any of the types now in use on city streets. I think such equipment will be developed and that we can do a good deal to hasten this development if we continue to tighten up on our specifications for true pavement surface and on our efforts to see that specifications are carried out. The general adaptations of finishing machines to concrete streets does not seem to involve serious difficulties provided we once get over being satisfied with the inequalities of hand work and seriously demand something better.

In the laying of our block pavements, the use of running templates is already common, but in the case of asphaltic mixtures, we are still entirely dependent on the eye of the raker and the diligence of the roller man. I feel sure mechanical equipment for raking and levelling will be developed. I know that several agencies are studying the possibilities at this time. Only recently we have heard of a road contractor laying asphaltic concrete under a standard concrete finishing machine, but the perfection of equipment for mechanical raking and rolling will require much time and experiment, and more immediate improvement must be secured by forcing more intelligent workmanship through the pressure of more intensive and careful inspection and checking.

True Contour Concrete Foundations.—It has been hard to persuade either foreman or workman that a concrete foundation to be covered by an asphaltic mixture, has any need to be practically true in contour. If there is a defect, why not let the asphalt gang take care of it, and a lot of that has been done with the result that our asphaltic layers will often vary seventy per cent in thickness, and that rollers working on un-uniform thickness must necessarily leave great variations in density as well as unfortunate waves in the surface.

We are going to specify that our foundation concretes be finished to the ¼-in. limit heretofore given to surfaces, and if necessary to secure this we are going to check our concrete bases with string lines on five foot intervals before the concrete has set. This is going to be hard work for the inspectors and harder work for the engineers to keep the inspectors doing it, but it is a task that paving engineers must undertake and carry through if they expect their work to meet with the full measure of public approval.

Taking Streets Out of Service for Paving.—The other thing that makes a citizen dislike us, is our propensity to tearing up the street in front of his store or home and keeping it torn up for two or three months in order to lay a new pavement. I feel that we have been too prone to stand on our rights of taking streets out of service in order to carry out such public work. We have been too inclined to do this work in the way it has always been done and to carry out our paving programs in the way best suited to the type of organization that our contractors have customarily placed on the work. We have not understood completely what serious economic losses our street closing signs and barricades involve. Where we have a residence street under construction, the loss is perfectly definite and the annoyance is quite obvious, but when commercial and industrial thoroughfares are taken out of service the excess costs imposed upon the abutters and through them on the whole community, are very serious. In the larger cities, the realization of this situation has been growing for some years, and in the year past definite efforts have been made to introduce improved methods.

How a Paving Job Was Speeded Up.—As an example of this definite planning, there was carried out during the past summer in St. Louis, the repaving of Washington Avenue, a major thoroughfare running through the retail and jobbing districts, in which the work was all done in accordance with the scedule set out in the contract and specifications. This contract provided for the removal of an old wood block wearing surface, the greater part of an old concrete foundation, the laying of new concrete foundation, and a granite block surface with asphalt mastic filler. The contract laid down an ideal schedule which involved an elapsed time of four days from the disturbance of the old pavement to the laying of the new. On account of weather conditions and some slight labor trouble, this schedule was not lived up to in every detail but it was very nearly met. In the main, the high speed was accomplished by the introduction of night work, the requirment that concrete be mixed in a central plant and hauled into the work as fast as needed, specifications for a quick hardening cement, and finally a requirment of refinement of organization and supervision in every possible detail.

All of these innovations cost money, some of them not so much as might be expected, but in every single instance when the expected accomplishment was explained to the taxpayer and the expected increased cost figured up, the plan met with approval.

Use of Early Strength Cement.—In this particular project, the biggest item of time saving came from the use of the early strength cement. This cement, one of several of this type now on the market, gave strengths in two days equal to 28 day portland cement concrete. It costs less than $4.00 per barrel as compared with $2.00 for standard portland cement. With increased production of cement of this type, there is every reason to expect further reduction in price, but even at present prices the increased cost per barrel will not exceed $1.75, and the cost per square yard for 6 in. foundation will not increase more than 30 ct. This will amount to an average increased assessment of 75 ct. per front foot or $30.00 for the 40 ft. store building. For this increased cost, the saving of ten days in the time of curing concrete, is secured. There would be few merchants who would not tell you that their loss on account of street closure would not be in excess of $3.00 per day, and that they would gladly pay two or three times that amount to speed up a paving program.

With the full appreciation of what we are doing in the way of improved engineering and contracting to secure stronger pavements, pavements better adopted to modern traffic, and with every consideration of the necessity for economies in cost where ever possible. I feel that the biggest tasks before the city paving engineers today, are to secure pavements of more perfect riding quality, and to carry out our paving construction with the least possible disturbance to living conditions or to commercial activity. Our success in these two respects, is of the greatest possible importance in holding the continued support of the public to sound paving programs.

An Automobile Casualty Every 40 Seconds.—Every 40 seconds someone is either killed or seriously injured in an automobile accident. During 1927, approximately 26,618 persons were killed and 798,700 injured in these accidents, the American Road Builders' Association asserts.

Court Decisions Relating to Public Health

From Public Health Reports

Town Held Liable for Sewage Pollution of Stream.—(Iowa Supreme Court; Stoven vs. Town of Calmar, Winneshiek County, 216 N. W. 112; decided Nov. 22, 1927.) An action was brought against a town for an injunction and damages on account of the pollution by sewage of a creek which flowed through the edge of plaintiff's farm. At the time of the trial in the lower court in October, 1926, the town had a sanitary sewage disposal plant about three-fourths completed. The trial court allowed the plaintiff damages, refused an injunction, and ordered the nuisance abated on or before Jan. 1, 1927. Both parties appealed. The supreme court approved the amount allowed as damages by the trial court, but held that the latter court "should not have made its decree final, but the same should have been in its nature interlocutory, giving the defendant a reasonable time in which to abate the nuisance, but holding jurisdiction for the final determination herein as to the rights of the parties in this respect." The supreme court stated that it did not know whether the nuisance had been abated and remanded the case to the district court "for the purpose of taking evidence upon the single proposition as to whether a nuisance still exists, and for the purpose, that, upon said hearing, such decree with reference thereto as may be warranted by the evidence may be rendered."—(Public Health Report, Jan. 20, 1928.)

Ordinance for Prevention of Pollution of Source of City's Water Supply, Located in U. S. Forest Reservation, Held Invalid.—(Washington Supreme Court; Brown vs. City of Cle Elum, 261 P. 112; decided Nov. 23, 1927.) The city of Cle Elum, under contract with the United States, took its water supply from a lake outside the city and within the limits of a United States forest reservation. The city, pursuant to statutory authority, passed an ordinance designed to prevent the pollution of the source of its water supply. This ordinance, among other things, prohibited swimming, fishing, and boating in the said lake. The United States had rented cottage sites along part of the lake, and the plaintiff in this case was a tenant of the United States. He sought to restrain the defendant city from enforcing or attempting to enforce the ordinance, particularly in so far as it prohibited or attempted to prohibit swimming, fishing, or boating in the lake. The validity of the ordinance was attacked on two grounds: (1) That its enactment was an attempted exercise of the police power of the city over lands and waters owned by the United States, and (2) that it was unreasonable. On April 28, 1927, a decision (255 P. 961) was rendered in favor of the city. Upon reargument of the case before the court en banc the question was presented to the court as to whether or not the legislature could constitutionally delegate to a city authority to exercise police power beyond its territorial limits and outside the boundaries of property it may own beyond its territorial limits by the passing and enforcing of ordinances assuming to regulate the conduct of citizens beyond such limits and boundaries. The State constitution provided:

> Any county, city, town, or township may make and enforce within its limits all such local, police, sanitary, and other regulations as are not in conflict with general laws.

The court then held that, in view of this provision, those statutory provisions, which purported to give to the city the power to pass such an ordinance as the one involved in the instant case, could have no validity. The court said:

> This delegation of its police power by the State to various municipalities is strictly limited to the exercise of that power within the limits of such municipalities. Authorities are cited to the effect that the State, by legislative enactment, might delegate its police power to various municipalities to be exercised beyond their limits, but those authorities will be found to have not arisen where a constitutional provision obtains such as the one existing in this State. In order for the appellant in this case to pass a valid ordinance under the sections of the code relied on, it would be necessary for the court to read out of the constitutional provision the words "within its limits," and no case has been cited to us, and we have been unable to find one, where legislation similar to that here under consideration has been sustained where there also existed a constitutional provision such as ours. * * * (Public Health Reports, Jan. 20, 1928.

Garbage Ordinance Held Reasonable.—(Washington Supreme Court; State (city of Auburn vs. Spiller, 262 P. 128; decided Dec. 21, 1927.) An ordinance of the city of Auburn, which required the maintenance and use of a metal garbage can by householders and operators of business places, also contained the following provision:

> * * * that in any prosecution for the violation of any provision of this section it shall be competent to prove that the person failing to furnish and provide or maintain such metallic can or deposit garbage therein as in this section provided is purchasing water from the city of Auburn for use upon such premises, and proof of such purchase of water shall be prima facie evidence that garbage is accumulating upon such premises.

This provision was attacked and the supreme court, after citing cases sustaining the validity of a legislative presumption of one fact from evidence of another, decided that there was in the instant case a rational connection between the fact proved and the ultimate fact presumed, saying:

> * * * The lawmaking body evidently reasoned that the purchasing of water from the city by a person in possession or in charge of premises located therein for use on such premises must of necessity be using them in such a manner as to accumulate garbage. While the reasoning may be somewhat attenuated, we can not conclude that it is without foundation. There are uses, of course, to which the water could be put which would not result in the accumulation of garbage, but such uses are occasional rather than general. The more common use of water by persons residing in municipalities is for household purposes, and to conduct a household of necessity results in the accumulation of garbage. In this connection it may be well again to call attention to the fact that the presumption to which the ordinance gives rise is not conclusive. It is a prima facie presumption only, and does not shut out from a party affected the right to show that the actual fact is otherwise.

The court also stated that "we find nothing unreasonable in the regulations of the ordinance now before us."—(Public Health Report, Feb. 24, 1928.)

City Held Not Liable for Use of Land as Garbage Dumping Ground by City Scavenger.—(Mississippi Supreme Court, Division B; City of Laurel vs. Ingram, 114 So. 881; decided Dec. 12, 1927.) An action for damages was brought against the city of Laurel on account of the use of plaintiff's land as a dumping ground for the garbage of the city. The city employed a scavenger to remove and dispose of garbage and other refuse matter, including dead aniamls, from residences and business places, as well as the city garbage and refuse proper. Fees for the scavenger's services were fixed by the city, and were paid by the property owners to the scavenger. The charges for the removal of the city garbage proper were paid by the city itself. The scavenger was to provide his own dumping ground, and the city retained no control over him as to how or where he should dispose of the garbage. The plaintiff recovered in the lower court and the city appealed. The supreme court took the view that the city was not liable, basing its decision on the ground that the scavenger was an independent contractor. The court said:

> If the city scavenger, in the present case, was an independent contractor, it is wholly immaterial whether appellant, in providing for the disposition of garbage and dead animals, was acting in its governmental, or in its private corporate capacity. In either case, there would be no liability on the part of appellant for the damage done appellee's land by the scavenger in the performance of his work. The selection of the dumping ground would not be the act of appellant, but the act of the scavenger, the independent contractor, for which the latter alone would be liable to any person thereby injured.
>
> We see no escape under the undisputed facts of this case from holding that the city scavenger was as much an independent contractor as the sanitary contractor was in the Shepperd Case. Knowledge on the part of the city authorities that the city scavenger was trespassing on appellee's property did not make the appellant liable; nor did the fact that, when appellee made complaint to the mayor of what was being done, the latter undertook to stop the practice. The mayor could not bind appellant in that manner. He had no right to direct the scavenger where to dump the garbage and dead animals.—(Public Health Reports, Feb. 17, 1928.)

Collection of Ashes and Rubbish Held to be a Governmental Function.—(Ohio Court of Appeals, Cuyahoga County; Gorman vs. City of Cleveland et al., 159 N. E. 136; decided May 2, 1927.) The plaintiff brought an action against a street railway company and the city of Cleveland to recover damages for injuries received while he was a passenger on a street car. It appeared that, while the plaintiff was attempting to alight from a street car, the car was struck in the rear by a city truck used to collect ashes and rubbish from residences and business places within the city, and that the plaintiff was injured when the sliding door on the street car closed upon his foot. The trial court rendered judgment in favor of the city on the ground that the collection of ashes and rubbish was a governmental, and not a proprietary function. The court of appeals affirmed the judgment of the lower court.—(Public Health Reports, Feb. 17, 1928.)